Frontispiece.

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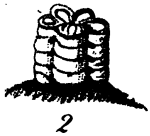

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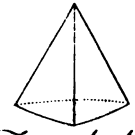
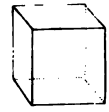
1 *The Encrinite or stone lily.*

2 *Columnar star-stones.*

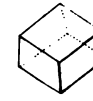
Forms of Crystals.



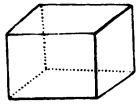
Tetrahedron.



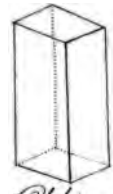
Cube.



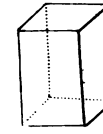
Rhomboid.



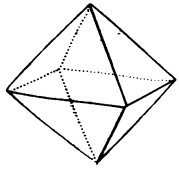
Rectangular Prism.



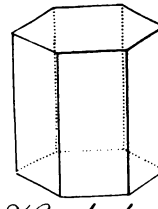
Oblique Prism.



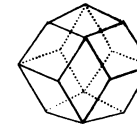
Right rhomboidal Prism.



Octahedron.



Hexahedral Prism.



Dodecahedron.

RUDIMENTS

OF

MINERALOGY:

DESIGNED FOR

YOUNG PERSONS,

WITH REFERENCES TO THE COLLECTION OF MINERALS IN THE BRITISH MUSEUM.

TO WHICH IS ADDED,

A short Introduction to the Study of Fossils.

BY MARY ANNE VENNING,

AUTHOR OF "RUDIMENTS OF CONCHOLOGY," &c.

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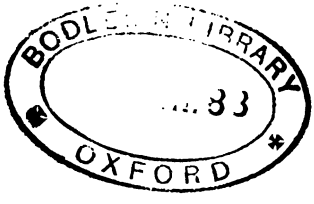

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MINERALOGICAL TERMS.

Acicular, composed of long, slender, straight crystals.

Amorphorous, without regular form.

Arborescent or *dendritic*, branched like a tree or shrub.

Base, the substance to which an acid is united.

Botryoidal, like a bunch of grapes; in globular forms, such as are found in chalcedony, wavellite, &c.

Brittle, when the particles fly off in cutting: a mineral will break off, when it will not yield to the point of a steel knife forcibly drawn over it.

Capillary, hair-like.

Cellular, having cells or pores.

Compact, when no distinct parts are to be seen.

Conchoidal, shell-like; when the convex or concave impression of shells appears on the surface.

Cube, a solid figure of six equal sides.

Decrepitates, when the mineral breaks or splits into fragments; the water in the crystal is changed into vapour, or the air in the interstices explodes.

Drused, covered with minute crystals.

Deliquesce, to melt, by imbibing moisture from the atmosphere, like salt of tartar, or pearl-ashes.

Double refraction, when a mineral presents two images of an object seen through the crystal.

Dodecahedron, a figure with twelve sides.

Effervesce, to foam or froth up.

Elastic, when a substance, on being bent, returns to its original form, like mica.

Embedded, when the mineral is found in another substance.

Foliated, in layers, like the leaves of a book.

Fracture, is the new surface that a mineral shows after it has been broken.

Friable, when the particles adhere slightly.

Fluate, is any mineral in which the fluoric acid is united with a base, as with *lime*.

Glance, shining.

Granulated, when a mineral is formed of a collection of small visible particles.

Hexahedral, with six sides.

Intumesce, to swell or bubble up.

Incombustible, not to be destroyed by fire.

Lamellated, formed of thin plates.

Malleable, capable of being beaten out with a hammer.

Nodules, irregular globe-shaped masses.

Octahedron, a figure with eight equal-sided triangles.

Opaque, when *no* light is transmitted.

Phosphorescence, a feeble light given by some minerals when rubbed together, or thrown on a hot substance.

Prism, a column of several sides: common starch separates into five or six sided prisms or columns.

Pulverulent, in a state of powder or dust.

Radiated, when the crystals diverge from a centre.

Rhomboid, a figure with the opposite sides and opposite angles equal.

Sectile, when a mineral may be scraped like slate pencil, and the particles do not fly off.

Striated, slightly channelled in parallel lines.

Stellated, see *radiated*.

Stalctitic, when the mineral is formed of lengthened rods, pointed towards the end; formed like *icicles*.

Stalagmites, flat, botroyidal masses, at the bottom of caverns.

Specular, having a smooth, shining surface, like a mirror.

Semi-transparent, when objects are seen indistinctly through a mineral.

Tabular, when the crystals are nearly flat.

Translucent, when light is transmitted.

Transparent, when objects may be distinctly seen through the mineral.

Tetrahedron, has four equal-sided triangles.

Unctuous, greasy to the touch.

Vesicular, porous, sponge-like.

Vitreous, having the appearance of glass.

NOTE. The term *crystal* is derived from the Greek word *crustallos*, ice. It was afterwards applied to rock crystal by the Romans, who thought the substance was water hardened by the continued frosts of the Alps.

ERRATA.

Page 60, line 12, *for* calcedony *read* chalcedony.
— 81, — 15, *for* bolonian *read* Bolognian.
— 90, — 9, *for* prevail *read* prevails.

RUDIMENTS OF MINERALOGY.

CHAPTER I.

INTRODUCTORY.

"A WALK!" exclaimed Arthur, "and then a breakfast at the foot of L—— Hill. Here is the signal," continued he, raising his hat upon a pole, to his sister Helen's open window. Then he began singing her favourite lines:

> "Wild sings the mountain lark, bird of the air,
> And down in the valley there's music as rare;
> Fresh blows the morning wind, bright looks the day,
> Up to the heather hills, Lilian, away!"

Helen quickly answered the signal, and hastened down, followed by her little brother Frank.

"Let me go, let me go also," he cried, seeing them both prepared for walking.

"You go, Frank!" said Arthur: "no, no; go in, we cannot take you so far."

"Oh! I must," exclaimed the little boy: "I do love Mr. C. He helped me to make a grotto last night."

"Stay, my dear," said Mr. C. who now joined them; "make less noise, and do not say you *must* go. Tell me, first, if you can walk a long way."

"Yes; I can walk as far and as fast as Arthur or Helen, up hill and down hill: mamma will tell you so, indeed, sir."

"Go then, and ask leave to walk with us. I see no objection, Arthur."

"I know he will be troublesome, sir," replied Arthur: "he will ask you as many questions as he does Helen; and she encourages him to look for all kinds of minute things. He knows every corner at home, where moss or flowers are to be found."

"I am pleased to hear it, Arthur. He is beginning early to lay up a store of knowledge and pleasure. What pursuit occupies your leisure hours?"

"I like drawing and reading. I attend a little to botany. I am very fond of hearing about farming: I should like to be a farmer when I am old enough."

Helen now returned with Frank, who had

obtained full permission to do as Mr. C. thought proper; and the party proceeded on their excursion.

A hilly country was new to these young people; and in bringing them to visit her friends, Mr. and Mrs. C. who had lately fixed their abode in a part of Surrey, remarkable for the beautiful scenery of its hills, their mother hoped at once to gratify and improve them. Mr. C. was fond of the children, and had requested their mother, who was a widow, to allow him liberty to take them long rambles, while they remained in the country. He also believed that he could not more effectually prove his esteem for his departed friend, their father, than by encouraging, or instilling into their minds, the love of natural science.

General admiration of the country, and the beautifully shaded lanes through which they gradually ascended the hill, occupied the first mile or two, till Helen's attention was turned to some remarkably fine moss. "It is not feather-moss," said she, "I think; yet it is *like* proliferous moss."

Frank thought the branches looked like little trees. Mr. C. told them it was *tree* feather-moss. Helen was charmed with the sight of a species she had long known by description; and Frank's hands were soon full of it for his sister.

"We do not find this moss in our neighbourhood," observed Helen, "though we have woods and shady places; and this is such light ground, while in most parts round us, the earth clings so to the roots of the plants."

"What is the soil of your garden and of the land round you, Arthur?" said Mr. C.

"I do not know," said he; "I never think about the nature of the soil."

"And how can a person expect to become a good farmer, who is unable to distinguish different soils. He would sow turnips in clay, and saintfoin in sand."

"Now I recollect, it must be a clay soil; for quantities of bricks are made in some of the fields."

"That is called plastic clay, of which there is a large portion near London. Beneath the surface, the noted *blue clay* extends widely over the county, and some of those adjoining. Shooter's Hill is said to consist of plastic clay on the surface."

"But I never saw any *blue* clay near London, sir," said Arthur: "it is *yellow*."

"Every where around London, and beneath the bed of gravel upon which the city is built, a stiff blue clay prevails, to the depth of five hundred feet in some parts. Norwood Hill, and High Beech in Essex, are both hills formed of *the London* blue clay."

"Then Highgate, and Hampstead, and Ludgate, and Holborn hills are all blue clay, below the surface. How very curious it must be to find out what lies so far under our feet. I did not think that there was any thing remarkable in the soil round London. It seemed to me all garden and field-land."

A sudden turn in the road brought them beneath a high shelving bank, composed of yellow sand, with hard, dark-coloured masses intermixed.

"Oh, what a fine place!" said Frank; "may I have some of these stones?"

Mr. C. drew out a strong hook, and broke off a fragment. "Feel the weight of that piece, Arthur," said he.

"Is it sand?" asked Helen.

"Take your magnifying glass."

Helen found the sand-stone composed of small half-transparent pebbles, with a few green particles among them.

"There is no blue clay here, I think," said Arthur.

"No; that is green sand which prevails in the hill we are ascending. The yellow tint of the sand is caused by iron: the harder portion is iron-stone. Green sand is met with in many parts of this island. In this neighbourhood it is more yellow than green."

Look," said Frank, "here is a moss, as stiff as a piece of fir-tree; and such a length!"

"That is wolf's claw moss. It shows that we are on high ground. I have it from the Welch mountains. We ourselves are nearly a thousand feet above the level of the sea."

With a pocket-telescope the party discovered many interesting objects. Mr. C. pointed out to them the range of hills called the *South Downs*, and told them that they were upon one of the heights that form the *North Downs*.

Before they left the hill, Helen, assisted by Mr. C., had collected several rare and curious plants; and Arthur was more careful than usual to examine, before he threw away plants as not worth notice. Frank, with his basket filled with treasures, mineral and vegetable, twisted a large branch of wolf's claw moss round his hat, as the best way to carry home plenty of it.

The good woman, in whose cottage a breakfast was prepared, informed Mr. C. to whom she was well known, that a new pit had lately been dug near to her house, and that the men had found some curiosities in the earth. Leaving the children to rest themselves, he went in search of the spot, and returned with several fossils. "When you know the value of them," said he, "you shall see them again."

"I know green sand, and iron-stone, and

flint: I have some of my own now," said Frank.

"I think," observed Helen, "we had better make a little collection while we stay, that we may remember, more clearly, what our kind friends explain to us."

"Do, Helen; and I will pick up all sorts of stones for you."

"And I," said Mr. C. (pleased to find them leading, of their own accord, to the subject in which he desired to see them interested,) "I will give you the proper names, and add a few minerals, which you will not meet with in the chalk and sand of this district."

"Is chalk to be found here?" asked Arthur, as they walked home.

"It abounds. Look at yonder hill, the chief feature in our landscape, in former times called the *White Hill*, from the striking appearance of its chalky slopes. The whole range towards the east is of the same formation."

"Shall we find chalk near London?"

"Blackheath, Charlton, and the vicinity, will afford you chalk *beneath* the surface, which is brownish sand. The chalk-pits at Dartford and Gravesend are noted. You shall walk with me to the chalk-pits in this neighbourhood, which do not afford flints in quantities, like those near London."

"Is not all chalk of the same kind?"

"The widely-extended beds of chalk are divided into two grand portions, which are termed *upper* and *lower* chalk-beds. The upper chalk contains layers of flint: the lower chalk, few or none. The science which teaches us to distinguish the masses of which the earth is composed, is called *Geology*."

"I think I should like the study very much."

"But there is another science, very necessary to those who study geology, and in itself most useful and entertaining; I mean *Mineralogy*. The great masses that form the mountains, hills, and plains, are composed of a vast variety of substances, differing in form, nature, and appearance. If you will give me your attention for a short time every day, while you stay with us, I will endeavour to make you acquainted with some of the more common species of minerals. You will find that the interior of this beautiful earth is as well worthy attention as the surface; and thus a new source of information and pleasure will be opened to you."

The proposal was gratefully accepted; and many questions concerning the new study were eagerly asked and kindly answered during the walk home.

"I see where you have been this morning," said Mrs. C. on the return of her young visiters.

"Only look at my basket, ma'am," said Frank: "Mr. C. says these are minerals."

"I see you have rather a heavy load; and your contrivance for bringing the moss is a very good one."

"And now," said Mr. C., "I advise you all to sit and rest. Put your treasures in order likewise, lest they should be injured by lying about. You will find a flower-press in the hall, and a few vacant shelves in the study. In the evening I shall have a leisure hour to talk farther with you about minerals."

"When will Mr. C.'s leisure hour come?" said Frank to Helen. "I do not think that he has forgotten us; but perhaps he does not know that I go to bed before you and Arthur."

"We must wait patiently. You know we have had a great deal of pleasure to-day already," observed Helen.

The hall clock chimed half-past eight as Mrs. C. entered the room. "Frank," said she, "you have leave to sit an hour longer with us. Come with Helen into the study, and take your supper."

Frank and his sister forgot the supper-table

when they opened the door of the study, where they beheld a new and beautiful sight. The windows were closed: several candles were placed upon a large table, on which a number of minerals were arranged. The children were charmed with the glittering spars and ores that reflected the light from their surfaces. Helen thought that mineralogy must be a beautiful study; and Arthur eagerly enquired if it was very difficult.

"More so than conchology or botany," was the reply; "but by beginning to examine substances that are easily known, you will find the difficulties gradually lessen; you will gain a number of ideas on the subject; and in time you may be able to understand the works of mineralogists."

"Shall I ever understand the works of great mineralogists?" said Frank. "I am only eight years old; but I should like to learn the names of these beautiful things on the table."

"I do not doubt, my dear, that you will be as familiar with *calcareous spar*, and *quartz*, and *gypsum*, as you are already with mosses and lichens."

"Will Helen know the soil when she sees it?"

"Certainly; and she will be able to judge of the soil by the plants she finds."

"That will be delightful!"

"But," said Helen, "if specimens of minerals are dear, I am afraid we shall not find ourselves rich enough to buy them; and mamma often says, that expensive pleasures are not the most gratifying."

"Costly specimens are quite needless," my dear Helen. "Look at those minerals at the lower end of the table: they are some of my first purchases, when I was a boy. Few cost me more than a shilling, some of them not more than a fourth of it."

"The fourth part of a shilling is threepence. Oh, Helen, what a good thing! a mineral, shining like gold, for threepence!"

The little boy's pleasure and surprise amused the whole company; Mr. C. availed himself of the interest with which he examined what he called a piece of gold, and endeavoured to impress them with the necessity of examining closely, before they ventured to decide upon the kind of mineral they might observe.

"Do not think that this mineral is really gold, Frank: it is much harder. Many persons have been deceived by the resemblance of one mineral to another in outward appearance, and have been great losers from the want of a little knowledge on the subject. A substance called *mica* has often been mistaken for

gold, and much expense had been incurred, before the mistake was discovered. The mineral before us is *iron pyrites.* Observe me. It strikes fire with this steel: *gold* will not produce sparks in this manner. *Iron* will dissolve in the strong acids; *gold* is soluble only in one particular acid: it is unaltered in the hottest furnace. You all know that iron can be melted, and cast into various forms; it can also be *welded,* or made to unite, if it is in separate pieces; gold cannot. There are many other distinctions between these two metals, but those I have just noticed would be sufficient to prevent you from taking iron for gold."

"Are acids much used to discover the nature of minerals?"

"The mineral acids called *vitriolic* or *sulphuric, muriatic,* and *nitric,* are of great use in mineralogy."

"We know two of them: mamma has shown us how the blue colour of vegetables will change, if an acid is poured upon it."

"Nitric acid, which is procured from nitre or saltpetre, is very powerful: the fumes are suffocating, if the phial is left long unstopped. The vapours soon destroy a cork, and often force it out, therefore it is necessary to use a glass stopper. You know something of geometrical figures, perhaps."

"Mamma has taught me a little," said Helen, modestly, "and Arthur learns at school."

"And I know cubes, squares, angles, rhombs, and prisms," said Frank: "salt is a cube. Do look, Helen! the iron pyrītes, that we have been examining, is full of little cubes."

"Iron pyrītes very commonly crystallize in a cubic form."

"I thought," said Arthur, "that a crystal was a *transparent* substance, like glass or ice."

"A *crystal*, in mineralogy, is any regularly formed body, whether clear or opaque, having many sides. Earthy and metallic minerals most generally are found in a crystalline form: you will perceive this easily, as we proceed in our study."

"That would be another means of determining the kind of mineral," said Arthur.

"The form of the crystal is of essential use; but the same species of mineral is observed to crystallize in a variety of forms; and different mineral substances assume the same form. Iron pyrītes and gold, for instance, both crystallize in cubes"*

"What beautiful purple cubes I have found in this tray!" said Helen: "here are some, clear as glass, and dark-coloured ones among them: are they all the same mineral?"

* See the plate.

"The label will answer your question, my dear," said Mr. C.: "I hope you will soon have sufficient knowledge to determine without assistance."

"*Cubic fluor spar, with galena*, is written on the label. I am desirous to know how any one can be *sure* that this dark-looking cube is galena."

"That you may ascertain very easily, Helen; but we shall do well to proceed regularly."

"But," said Arthur, "this yellow mineral has not the least resemblance to *iron:* I can believe that iron might be mixed with the sand, in the dark, heavy stone we met with this morning."

"I will mention another name for the pyrītes. It is also called *sulphuret of iron*," said Mr. C.

"Now I begin to understand. *Sulphur* is mixed with the iron in this mineral, and changes the colour. I am sure I shall enjoy learning mineralogy: it seems full of wonders."

"And then," said Helen, "we may go on to geology, and try to know the rocks and mountains of this wide earth. It must be so grand to know what the Alps and Andes are formed of, though we may never see the mountains themselves."

"There is no reason that you should not proceed to that very interesting study; but before

we can talk of granite, mica-slate, felspar, sandstone, and serpentine, we must have clear ideas of these bodies, which are all minerals in vast masses. Mineralogy, therefore, is the first object of our attention. I wish you to remember, that it is not my intention to lead you through a complete system of mineralogy, but to make you acquainted with the most common minerals, and to describe some of the rare species, which will interest you far more, when you are familiar with the characters of the division to which they belong. It is useful to understand something of the nature of objects that we meet with so frequently, even if no further advance is made in the science."

"Where can we see rare minerals?"

"The collection in the British Museum is considered the first of its kind, and to that you can have free admission. The museum of the Zoological Society is accessible; and many of the provincial towns are forming collections, not only of minerals, but of other interesting objects connected with natural history. Private collections you may occasionally meet with, and sales of minerals are sometimes announced, which will afford you the means of purchasing a few specimens; and you may also derive benefit by examining the collection. Mineralogy, like conchology, is a study fitted for young persons whose usual

abode is in a town; and their occasional excursions into the country and to the sea-side, will be productive of knowledge as well as pleasure. Every excavation is an object of interest to the mineralogist, and the cliffs of the sea-shore, the pebbles on the beach, will frequently reward the attention of a careful observer. The pits of flinty chalk you will find a proof of my assertion. Small collections of minerals may also be purchased, and are very useful to those students who can have little aid from the friends with whom they associate. I have bought those specimens by degrees, as I chanced to meet with them; and I think that I have received more pleasure in following this method, than in obtaining a collection at once."

Helen and her brothers spent a little time in admiring some of the various minerals on the table, while Mr. C. conversed with their mother. He frequently heard the exclamation, "Here is a beautiful piece! This is a golden branch, and there are green cubes!" Frank was sure that he had found white sealing-wax and stone peas.

At length Mrs. C. advised them to take some refreshment, and return in the morning to the study, to observe the effect of daylight on these very amusing objects.

CHAPTER II.

CLASS I.—EARTHY MINERALS.

Insoluble in water, tasteless; incombustible at a white heat.

CALCAREOUS MINERALS.

Carbonates of lime. (Yield to the knife: effervesce with acids.)

THE next morning, Mr. C. told his young friends he was at liberty to attend to them, and withdrew to the study. Frank was following; but Arthur said, it was not likely that he could understand half Mr. C.'s conversation, and he would only disturb them.

"We shall try him, however, Arthur," said Mr. C. "He showed no disposition to be troublesome last night. Besides, I shall show you many minerals that even he ought to be acquainted with."

"I am sure I should like to look at these beautiful things while you are speaking of them," said Frank, with the tears ready to start, at the prospect of being sent away; "and perhaps I

may remember some of their names too. I know *gymnostomum*, and *phascum*, and *sphagnum*, and more hard names of mosses, that Helen taught me. I will not touch a single piece of mineral without leave."

"Sit down then, my little fellow, and you shall examine the minerals, when you can understand what I am speaking about."

"May I ask questions, then?"

"Certainly; and I will endeavour to answer them."

Helen smiled at her little brother, and looked gratefully at Mr. C., who now brought forward several phials with glass stoppers, a knife, a steel for striking a light, a watch-glass, some thin glass rods, pointed at one end, a wax candle, some pieces of charcoal, and a small brass tube.

"You will soon discover the use of these articles," said he; "and your botanical magnifying glass will be often necessary: so will these forceps, to prevent you from burning your fingers. Here are likewise the mineral bodies called *calcareous spar*, *fluor spar*, *felspar*, *quartz*, and *corundum*, which are useful for trying the different degrees of hardness in minerals. Window-glass, though not a natural substance, is also a good test. *Corundum* is used to try the hardness of precious stones: it will scratch all minerals but the diamond. Now tell

me, Frank, what is meant by the form of a mineral."

"Whether it is a cube, or a prism, or a rhomb, or many other shapes."

"Does Helen understand the term, *combined?*"

"Mixed together, as the iron with sulphur, in the pyrites we saw last night."

"Can you recollect an example, Arthur?"

"I believe the paint called *cinnabar* is said to have mercury in it. I know that mercury is like silver in its colour, therefore I should think that cinnabar is a combination of mercury with some other mineral."

"It is the character of some minerals," continued Mr. C. "to effervesce with acid. others are wholly uninfluenced by the strongest acids. Some yield to the point of a steel knife; others constantly resist it. Many minerals will scratch window-glass, while those that *appear* equally hard, make no impression: others scratch quartz, some only felspar. You have already seen that it is one character of iron pyrites to strike fire with steel, so will the finest rock crystal; while *copper* pyrites never give sparks. Minerals have been divided into classes, orders, and genera, like shells and plants. I shall adopt that arrangement which divides mineral substances into four classes. The first class contains the *earthy*

minerals, the second, *inflammable minerals*, the third, *saline minerals*, and the fourth, the *metallic minerals*. Some writers make the metallic class the first, but I think you will find it the most difficult; we will therefore begin with the earthy substances, many of which you already know, and defer the metals till you are farther advanced in the study. You have already been told, that I wish to make you familiar with the *objects:* the various modes of arranging them you will afterwards easily comprehend. *Marble* is an earthy mineral; *sulphur*, an inflammable or combustible mineral; common *salt*, a saline mineral; and *iron pyrites*, a metallic mineral. *Lime*, *magnesia*, *silex* or *flint*, and *argilla* or *clay*, are earths, and when perfectly free from all other substances or bodies, they are *snow-white:* they all agree in this one character."

"Is flint, *earth?*" asked Arthur, with surprise.

"Flint is siliceous earth mixed with lime, clay, and iron. By heating it, the white colour is restored."

"But clay is yellow, and sometimes blue. You were telling us of the London blue clay."

"What is the colour of a tobacco-pipe?"

"White; and pipes are made of clay: I recollect, it is called *pipe-clay*. I know quicklime and magnesia are white."

"The first division of earthy minerals, contains those that are principally composed of *lime earth*, combined with an acid. They are called *calcareous* minerals. I shall begin with *carbonate of lime*, that is, lime earth and carbonic acid gas: earthy minerals so combined, are called *carbonates* of lime. The specimen before us is the very common substance called *chalk*. We shall first try the two characters that distinguish the carbonates from all other earthy minerals. *They yield to the knife, and effervesce or froth with acids.* Place a small piece of chalk in the watch-glass, and I shall drop a little muriatic acid upon it."

"How it foams!" exclaimed Arthur; "and there is a vapour issuing from the chalk!"

"That is the carbonic acid. I have cut the remainder of the piece in two: it is plain, therefore, that it yields to the knife, and we may conclude that chalk is a carbonate of lime. But there are many other carbonates: our next business is to find out the particular species. Touch the chalk, it stains your fingers; apply it to your tongue, it adheres to it. The sense of feeling is often a test: chalk feels meagre; it breaks into sharp, angular fragments; it is very light, and nearly swims on water. All chalk, however, is not equally light or soft: some beds are found sufficiently hard for building."

"Chalk is a very extensive formation in this island. The cliffs of Dover, the high promontory Beachy Head, the cliffs from Folkstone to Dover, and from that town to Deal, are of a similar nature. The two capes, called the North and South Forelands are chalk. I will mention one place more—the western promontory of the Isle of Wight, together with those singular pyramidal masses, called the *Needles*, afford another interesting display of 'England's chalky cliffs.' How many hearts have rejoiced at the sight of them, after a long abode in foreign lands, or escapes from the perils of winds and waves! Chalk hills are remarkable for their smooth, rounded outline. The beech-tree flourishes on a chalky soil. You have seen that the box-tree thrives in it. Numerous fossils occur in chalk rocks, which will interest you very much when you become acquainted with them. Iron pyrites, also, are frequently found in the form of round masses, called *brass lumps*. In the lower chalk, with us, they have a splendid appearance: when broken, the surface is radiated."

"What a strange-looking stone this is!" said Helen, "pierced through in many parts: I do think it is made of chalk, it is so light."

"I will repeat the characters of the mineral: do you observe whether the stone answers to them," replied Mr. C.

"It does. How very agreeable it is to find the nature of a substance thus; but the holes are not accounted for."

"The chalk stone is pierced by the shell-fish *Pholas* or *gaper*, or perhaps by a species of muscle: harder substances are often perforated by them. The stone is rounded by rolling in the sea. You must have seen similar pieces of chalk, with long, dark sea-weeds fastened to them: they are very common on the beach at Brighton, and other places on the coast."

"I suppose we must have overlooked a great number of curious stones and minerals, when we were at the sea-side."

"That is scarcely to be doubted, Arthur: There is another piece in the tray, that you have not examined: do you know it?"

Helen said that the mass was only whiting; and being asked the difference between chalk and whiting, she confessed her ignorance.

Mr. C. told her that chalk, purified by pounding and passing through water, to separate it from the particles of silex, is called *whiting*. Arthur knew that lime is burned, and used as cement, called *mortar;* and easily understood that the use of burning or *calcining* lime and chalk, is to force out the carbonic acid, and that it becomes *quicklime*. He was told that chalk is much used near London, for making mortar,

and was showed some specimens of *compact*, or common limestone, of a grey and rather blue colour.

"Some beds of limestone," said Mr. C. "have been called *shell-lime*, from the quantity of shells they contain."

Arthur enquired where shell-limestone could be seen; and was told that Derbyshire, Yorkshire, and other parts of England, afford it; and that beds of shells occur at Woolwich, in the sand-pits.

Helen asked if chalk and limestone were quite the same; and being desired to try the knife and an acid, she found that, although the limestone effervesced, it did not fall to pieces, while chalk entirely dissolved.

Mr. C. added, that it contains portions of silex, clay, iron, and water—that it is often capable of a fine polish, like marble.

Several beautiful little slabs of marble were next brought forward. "These are examples of *granulated* limestone," said Mr. C. "A mineral is *granulated*, when it is formed of a collection of small visible concretions or grains. The celebrated *Parian* marble, so famed in Grecian sculpture, and remarkable for retaining its delicate wax-like lustre and softness for ages, is nothing more than lime earth, carbonic acid, and water. *Pentilic* marble was also in great

estimation at Athens; but its inferiority may be seen by any one, who will observe the surface of the Elgin marbles in the British Museum. The outside of the sculpture has become decomposed, and appears earthy. This is *Carrara* marble from Genoa, it is milk-white: it is also called *statuary* marble. The deep black slab next to it, is from Scotland; it is a variety of the Italian *Lucullite*, so named from the Roman consul, Lucullus. This marble is very heavy: a strong sulphureous smell is often perceptible, when it is rubbed. It consists of lime, iron, sulphur, and other substances; but you will find that it maintains its character of a *carbonate*. You can draw a knife across it. Do not drop the acid; take a glass rod, dip the point into the phial, and apply it neatly to the edge of the slab: you can perceive the effervescence. If the acid does not act sufficiently to satisfy you, repeat the trial. This method is very convenient, when the specimen would be injured by breaking off fragments to place in the watch-glass. Open that little parcel."

"What a beautiful piece! Rose colour, figured with green. This must be some valuable foreign marble."

"*Tiree*, a Scottish isle, has the honour of affording the marble. I give it to you, Helen: you will not forget that marbles are carbonates

of lime. The other packet is for Arthur: it contains *Mona marble*, from Anglesea."

"How finely the dark green and white colours are mixed!" said Arthur: "Helen's specimen and mine will make a show together. But are the green stripes and waves, lime?"

"The white part is limestone; the green shades are owing to serpentine and asbestus. In the British Museum there is a specimen of *flexible marble*, of a pure white colour, which bends with its own weight. Our next carbonate is very different in its appearance to marble: it is called *mineral agaric*, or *rock milk*. It is found adhering to rocks like a fungus: it stains the fingers. In Switzerland it is used to whiten houses."

Mr. C. now removed the tray of marbles, and produced another, with crystallized specimens of a yellow and white colour. "Beautiful as these appear," said he, "they are very common. You can ascertain their nature yourselves. You find how very easily they yield to the knife, and effervesce with acid. These varied forms are crystallized lime, usually called *calcareous spar*. The crystals are known to assume more than six hundred different forms, but the first or original shape of the crystal is *rhomboid*.* Most of these crystals are transpa-

* See the plate.

rent, and have the power to refract doubly. This specimen of *Iceland spar* will cause the head of the pin I place near it, to give a double object."

"Two pins' heads," cried Frank, "quite plainly to be seen: oh, how wonderful!"

"This *foliated carbonate* will show you the rhomboid form of the crystals. Raise up a small piece with the knife: the fracture produces little sloping-formed squares, which are the rhomboids. Calcareous spar is found in chalk rocks, in green sand, in mountain limestone, and other rocks."

Mr. C. rang the bell, and his servant brought in a large coal, which he placed on the table. "Now," said he, "look carefully, and tell me what you observe."

"How often I have noticed these white and gold-coloured flakes upon coals," said Helen, "little imagining that they had any thing to do with mineralogy. With the glass I can see little white, opaque crystals, just the form of those in the foliated specimen."

"And they effervesce too," said Arthur, dropping muriatic acid into the watch-glass upon a piece he had taken off.

"This very common substance," said Mr. C. "is *crystallized lime*, often coated, as in the present instance, with iron pyrites, in flakes of a golden hue. You are surprised to find mineral

bodies upon our common fuel; but coals themselves are minerals, of which there are several varieties, as you will learn, when we come to the class of inflammable minerals."

"Then I will have a fine bright coal in my collection," said Frank: "may I take off some of the gold flakes from this?"

"My man will do it more cleverly than you can, for he is somewhat used to these matters: we took some pains this morning to find a coal with large crystals upon it. You will find plenty on the coals next winter, to exercise your skill."

The coal being removed, Mr. C. produced some long, brown, cylindrical pieces of lime, pointed at one extremity. "These do not look very interesting," said he; "but look at them well, they are *lime stalactites*, often found hanging from the roofs of cellars, under the arches of a bridge, and in damp caves. You shall now see them in another and more attractive form; crystallized, and known by the names of *calc-sinter*, or *calcareous alabaster*. A mineral is *stalactitic* when it consists of lengthened rods, round, and pointed at one end. Here is a beautiful variety, covered with little needle-like or *acicular* points. I have seen them coloured red, and green, but the specimens are rare: mine are only white and yellow. It is brittle, and easily frangible."

"I remember reading of some caverns, with such substances rising from the floors, and hanging from the roofs," said Arthur.

"When the crystallizations rise from the floor, they are termed *stalagmites*. The caverns of Antiparos, an island in the Archipelago, has long been a noted place for these beautiful minerals. Castleton Cavern in Derbyshire, and the Woodman's Cave in the Hartz Mountains, are noted places. There is a circumstance connected with calcareous alabaster, which will fix the idea of it in your mind: boxes for precious ointments were formed of it, in past ages; and it was a box of this kind, that the woman, mentioned in the Gospel, broke over the head of Christ. This alabaster was also formed in various articles for use or ornament, the caves affording large masses for the purpose. You have seen lime earth crystallized: in the specimen before you it is in a *fibrous* state; it has a silky appearance; the fibres are easily detached. That variety, so finely polished, with wavy lines, is *satin spar*, the other is *fibrous limestone*. Iron pyrites often occur with this variety."

"Here is another kind of calcareous spar," said Arthur, as Mr. C. put a specimen of *arragonite* into his hand, and then lighted the wax candle.

"I rather doubt that, Arthur," said Helen; "for it *seems* harder under the knife."

Mr. C. took the pincers, and placed a small fragment of calcareous spar in them, he then held it in the flame of the candle. "It neither melts nor splits," said he. When a fragment of arragonite was put into the flame, it *decrepitated*, or splintered. This decrepitation in the flame of a candle, is a very good distinction between calcareous spar and arragonite: the former is *unaltered* by the heat; the latter always splits into numerous particles. "The mineral is not calcareous spar, Arthur," continued Mr. C., "but a carbonate of lime called *arragonite*, because it was first found in Arragon, a province of Spain. Its prisms are six-sided, and striated lengthways. *Striae* are very small channels on the surface of a mineral. The yellow specimens are the same species. There is a small portion of an earth, called *strontian* in arragonite."

"I know this," said Arthur, as a spray of an oak-tree was placed on the table, entirely encrusted with a stony substance; "it is a petrified branch: both leaves and wood are turned to stone."

"The substance is *tuffa*, or tuffaceous limestone, extremely porous. The water of some springs contains this lime, and deposits it upon animal and vegetable substances, when they are placed in it. The tuffa has entirely covered this spray, but it is not changed, it is simply encrusted with the stone-like covering. I shall now

show you some very useful carbonates of lime: do you know the appearance of Portland stone?"

"It is a smooth, white-looking stone," said Arthur: "I think that square slab is like it. I know it is called *free-stone*."

"With the magnifier," said Helen, "the Portland stone is full of little round globules, and it is lime, I see, by the effervescence."

"*Portland stone*," said Mr. C., "*Purbeck stone*, *Bath stone*, *Ketton stone* or *roe-stone*, are all varieties of that very extensive tract of lime-stone, called *oölite:* it is called *roe-stone*, from the resemblance that it bears to the roe of a fish, when the globules are small; but when they occur as large as a pea, the name of *pisolite*, or *pea-stone*, is given to it. This yellow mass is also pea-stone: the globules here are very large, and I have seen them two or three inches in diameter: their structure is radiated; they sometimes contain in their centre a particle of quartz sand, round which the lime collects; sometimes they are empty. They are not uncommon. Oölite contains iron, and argillaceous or clay earth; it is not therefore a pure carbonate of lime. Many public buildings in London are constructed of free-stone or oölite. Ketton stone has been used for several of the colleges at Cambridge. I fear this grey stone will not be a favourite, when you have rubbed it. The

rocks on each side the Avon at Bristol afford it."

"The smell is not very agreeable," said Helen, "but I will try the acid and the knife upon it. Lime again, I think."

"Yes," replied Mr. C., "it is *swine stone*, a species not uncommon: the colour is sometimes very dark."

"Is this specimen swine stone?" asked Arthur. "It is of a blue colour."

"That is *Vesuvian limestone;* it contains a portion of water; in *common* limestone there is none. *Vesuvian* is found among the minerals that are ejected from the interior of the mountain Vesuvius. Our two next minerals contain *carbonate of magnesia,* in addition to lime earth. The first is *magnesian limestone*; the colour is pale yellow; it effervesces feebly with the strong acid, called *nitric.* Take care how you try it, Helen, it will stain the skin yellow."

"I think we shall be able to distinguish between common limestone, oölite, and magnesian limestone," said Arthur; "but is magnesian limestone used for building also?"

"Westminster Hall and York Minster are built of it. The stone is less liable to decay than common limestone."

"How very pretty the next mineral is! *Pearl spar* is written on the paper below it. It has

little flat rhombs, lying one over the other; they are pearly white: I shall know this again."

"Pearl spar is of various colours," said Mr. C.: "the brown variety is, in fact, an ore of iron. The mineral differs from calcareous spar, in its greater hardness, and in the entire want of transparency. Pearl spar, when scraped with a knife, is said to yield a reddish light. There is a species of magnesian limestone called *dolomite:* the colour is snow-white. I am not possessed of a specimen, but the Museum will supply my deficiency in all respects, with regard to the more choice specimens. Look into that glass case: there are two slabs, or rather planks, of a yellow colour."

"I see them," said Frank, "they look like soft cake; one might cut it."

"That is *flexible limestone*, the last of my store of carbonates of lime, that I think it useful to show you. I think we shall do well to pause here; the subject is new to you: it will be right to examine all the specimens again, before we proceed to the *fluates* of lime. I shall give you a list of the minerals you have seen, which will recall some part of my instructions."

The evening walk renewed the subject of the morning studies. Accompanied by their mother and Mrs. C., the children were led to some large chalk-pits, by their kind friend, and amused themselves with looking for fossils. They saw, with surprise, the depth of the stratum of chalk, and listened very attentively to Mr. C.'s account of the oölite and lias-limestone beds, in the neighbourhood of Bath and the surrounding country. They were pleased to hear of geological maps, and were glad to find that Mr. C. was possessed of several, which he promised to show them.

"Take up that lime, Frank," said Mrs. C.: "it lies at your feet."

Neither Frank, Helen, nor Arthur, could see any lime in the path, till their mother pointed out an oyster-shell.

"Is mamma right?" asked Frank.

"Perfectly: all shells are lime; so is coral. Your bones are partly made of lime; so are egg-shells."

"Lime in living creatures! oh, what a quantity of lime earth there must be in the whole world!" said Frank.

His mother asked if lime had ever been found in a pure state, unmixed with any other substance, or uncombined with any of the acids.

"Lime has never yet been found pure," replied Mr. C., "but it may be rendered so by chemical means: the lime of oyster-shells is nearly pure. But lime is, in fact, a *metal*, in combination with oxygen or pure air: it is called *calcium*, and resembles silver in its colour and lustre."

"More wonderful still!" said Arthur. "Have you any calcium, sir? I should like very much to see it."

"Calcium has the colour and lustre of silver: on exposure to the air it instantly takes fire, and burns with a white light, and becomes lime again, by absorbing oxygen from the atmosphere."

"What are you considering so seriously, Frank?" said Mrs. C., seeing him look very grave.

"I was only thinking," replied the little boy, "of one of my hymns. I understand better now, what Mrs. Barbauld means, when she says: '*Lo, these are but a small part of His wonders!*' for minerals are as wonderful as flowers, that grow out of the dark brown earth. Do *you* think so, mamma?"

"My dear child," said Mrs. C., much pleased with this unprompted application of a passage probably well known to most young readers, "your mother has taught you to know that you

have a mine more valuable than one of gold, for she has opened your heart to the love of nature and of God. Happy indeed are they, who, like the poet:

> 'Find tongues in trees, books in the running brooks,
> Sermons in stones, and good in every thing.'

CARBONATES OF LIME.

Chalk.—Stains the fingers; adheres to the tongue; fracture earthy.

Compact limestone.—Effervesces; but does not dissolve in acid; abounds in petrifactions.

Granular limestone, or marble.—Parian, Pentilic, Carrara marble. Lucullite, Tiree, Mona marbles.

Flexible marble.—Bends under its own weight; colour white.

Mineral agaric, or rock milk.—Stains much; nearly swims on water.

Calcareous spar.—Does not decrepitate in the flame of a candle; is scratched by fluor spar; crystals rhomboidal.

Iceland spar.—Refracts doubly; clear white.

Stalactites and stalagmites, or calcareous alabaster.—Calc-sinter; white, yellow, red, and green.

Arragonite, crystals striated.—Decrepitates in the flame of a candle; white, yellow, or grey.

Tuffa, or tuffaceous limestone.—Cellular, ramose, porous; grey or brown.

Oölite.—Portland stone, Bath stone, roe-stone, *(globular limestone.)*

Pisolite, or pea-stone.—Yellow; occurs in botryoidal masses; structure radiated; contains magnesia.

Swine stone, or fœtid limestone.—Grey or black; effervesces strongly in acid.

Vesuvian limestone.—A volcanic production from Vesuvius; colour blue.

Magnesian limestone.—Distinguished from common limestone by effervescing feebly in nitric acid; colour light yellow.

Pearl spar, or magnesian carbonate of lime.—White or grey; scratches glass.

Dolomite.—Granular; white.

Flexible limestone.—Variety of dolomite; soils the fingers; earthy, soft; fœtid when damp.

NOTE. The less pure varieties of chalk are *yellowish*, and sometimes *red*; specks of green earth are also found in it. The two last colours are probably owing to *iron*. Some chalk is powdered with black specks.*

* Outlines of the Geology of England and Wales.

CHAPTER III.

EARTHY MINERALS CONTINUED.

CALCAREOUS MINERALS CONCLUDED.

Phosphates, fluates, and sulphates of lime.

"I WAS remarking to you yesterday," said Mr. C. to his young pupils, when he met them in the study the following morning,—"that human bones, and indeed those of other animals, contain lime. Bones also contain *phosphate of lime.* I will show you a mineral formed of this phosphate, called *apatite;* this is green: other shades also occur. It burns with a green light, and effervesces *slightly* with hot nitric acid. Whole mountains in the province of Estramadura, in Spain, are formed of it. Apatite has been found in the granite of St. Michael's Mount, Cornwall. It is massive, and also crystallized. Here is another species, called *asparagus-stone.* It is soluble in nitric and muriatic acid, with very little effervescence. The colour, you perceive, is bluish green: it is prismatic, and the

sides are striated. The lustre is bright. Asparagus-stone is also called *conchoidal apatite.* Burnt hartshorn, of the shops, is a phosphate of lime. The farina of wheat contains it. The straw contains *carbonate* of lime and *silex*, which renders the stalks of large grasses so strong."

"I cannot imagine," said Helen, "how people find out this."

"By the assistance of chemistry," replied Mr. C. "Mineralogy is greatly indebted to that science. Chemical tests are among the most certain in ascertaining different minerals. A chemical test will assist in determining what our next specimens are *not.*"

"They are very beautiful," said Arthur: "I will touch one of them with a glass rod, dipped in all the acids in turn."

"But none of the acids have any power there, I see," said Helen. "Therefore, as Mr. C. says, it is *not carbonate* of lime, at any rate."

"Neither will it strike fire with steel," said Arthur, using all his strength to produce a spark.

"Gently, Arthur," said Mr. C. "that is a vain attempt. Try the knife. You find it gives way. This fragment of quartz will serve as test: it will scratch your unknown mineral. Observe the form of the crystals. They are cubes. Here

is a simple cube. I will take off the angles or corners of it. Now we have a crystal with eight sides, or an *octahedron;* which is the first, or primary form of *fluate of lime*, or *fluor spar.* You will recognize it more easily in the *massive* form. Look at these two vases."

"Derbyshire spar," said Helen. "Is this piece unpolished?"

"It is: the miners call the mineral *Blue John.* Here are purple, green, light yellow, and light green *cubes:* some are clear as crystal, and white. I see Helen is struck with the beauty of those pale purple cubes, that are *drused* or powdered over with small quartz crystals. Fluor spar then, yields to the knife: it is scratched by quartz; but it does *not* effervesce with acids. This will distinguish it from *carbonate* of lime or calcareous spar, which is scratched by fluor spar. Fluor is distinguished from *quartz* by yielding to the knife and not scratching window-glass. The cube is a very frequent form; but you have seen that it can easily be reduced to its first form, the octahedron. You are not to touch the acids without leave, Frank."

"I will not, sir," said Frank. "Now we have another kind of lime."

"And you have phosphate of lime in your own bones," said Arthur, laughing. "You do not want any specimens of it."

"And you have fluate of lime in your teeth," said Mr. C. "The human teeth contain the fluoric acid, which renders them more durable than they would have been by phosphate of lime alone. The acid, which is combined with lime, in the minerals before you, is used for etching on glass."

When the fluates of lime had been well examined, Mr. C. drew forward a tray with lime-earth in another form. Frank was pleased to see the substance, which he had called white sealing-wax; and admired two little figures on the tray.

"We shall not call it wax, now," said Helen; "and I do think this must be plaster of Paris, for here is a little figure made of it; but the other looks as if it were carved like marble."

"The substances before you are *sulphates* of *lime;* that is, lime earth combined with sulphuric acid, frequently called *gypsum.* It does not effervesce with acids: it yields to the knife easily, and even to the nail. It is softer than calcareous spar, and of a snow-white colour. When exposed to heat, it decrepitates, becomes friable or easily crumbled, and falls to powder. In this state it readily absorbs water, and then becomes solid. Gypsum is baked in an oven, in small masses, and then ground in a mill to a fine powder, which is *plaster of Paris.* That figure on

your left hand is of plaster: the other is carved in alabaster, or *compact gypsum*. You must be careful to distinguish between *calcareous* alabaster and *gypseous* alabaster."

"I think we shall recollect them," said Helen: "the stalactitic alabaster is so beautifully transparent, the gypseous is opake."

"The specimens of fibrous gypsum are beautiful. This prism, with its silky-looking fibres, is almost translucent; that is, it transmits light from the surface, but objects cannot be seen through it. Fibrous gypsum is distinguished from satin spar by its greater softness. That pretty little specimen with curls, is *plumose gypsum:* I give it to you, Helen. I will now show you crystallized gypsum, or *selenite*, which yields readily to the nail. In Russia, where it abounds, selenite has been used instead of glass. Hold this flat piece to your eye."

"Is it found in England?" asked Arthur.

"Very frequently. Selenite, in small particles, is a common impurity in spring-water, causing it to be hard."

"Pray tell me," said Helen, "the cause of this redness on the surface of the fibrous gypsum: it looks like red clay."

Mr. C. produced a piece of rock, of a deep red colour, veined with a white substance. "This," said he, "is the kind of rock in which gypsum

is found. It is *red marle*, or new red sandstone; a very extensive formation: it stretches across the island, from Devonshire to Durham. These white veins are the gypsum. The finer kinds of this mineral are made into necklaces and ear-rings: the coarser sort is used for stucco, plaster, and in some places for flooring. Gypsum occurs plentifully in various parts of Nottinghamshire and Derbyshire. About eight hundred tons are raised in the latter county for making plaster of Paris. On the coast of Sidmouth, whence my piece of rock was brought, the red, marly sides of the cliffs are veined with gypsum, from half an inch, or even less, to a foot in depth. The rock moulders away beneath the gypsum, and leaves it in shelves. I will find some more of this red marle for you: it may be useful when you begin to want examples of rocks in studying geology. Remember also, that gypsum occurs near Paris, where it is calcined and used as a plaster: hence its name, *plaster of Paris*."

"In the present limited extent of your knowledge, I shall not burden your memory with the hard words *datholite*, *pharmacolite*, &c. nor show you the minerals to which they are applied. You will meet with them; and they will, in time, become familiar.

"There are several other combinations of

lime-earth. I will merely mention one, which is *nitrate of lime*, or lime and nitric acid. It is found in the mortar of old buildings and in caverns, in the form of a powder, which *deliquesces* or melts, when exposed to the air. I have often seen it on the walls of an old stable in this neighbourhood. We will ask leave to look in when we pass by."

"Oh! can we not go to-day?" said Frank, "Let us see it now."

"No, my dear; there is a time for all things, as the wise man tells us. I strongly advise you all to beware of making these delightful pursuits the cause of too much excitation. You may become troublesome to those you associate with. Above all, never fancy that your pursuits or discoveries are of sufficient importance to withdraw the attention of others from objects or employments as interesting to them as yours can be; and in the company of fellow-students, always bear in mind, that they may be as quick in perceiving, and as accurate in observing, as yourselves. '*Be sober-minded, be clothed with humility*,' says Paul. What harmonious peace would prevail if we all obeyed the precept!"

"We shall endeavour to recollect your advice, sir," said Arthur. "Mr. Morris often reminds me of the maxim, *est modus in rebus;* and I believe I need to remember it," said he, frankly.

"I like your open avowal, Arthur: I doubt not you will learn to be wise in time, for you are alive to your own defects, and willing to acknowledge them. But I must leave you now. That paper contains the names of the minerals we have been examining."

CALCAREOUS MINERALS.

PHOSPHATES OF LIME.

Apatite.—Colour green, resembles the emerald. Softer than fluor spar. Crystals six-sided prisms.

Asparagus stone.—Soluble in nitre and muriatic acid. Colour blue-green.

FLUATES OF LIME.

Yield to the knife, scratch calcareous spar, do not effervesce with acid, unless concentrated, and are scratched by quartz. Form of the crystals eight-sided. Cube very common also.

Fluor spar.—Massive, called Derbyshire spar and Blue John.

Cubic fluor spar.—Colours blue, green, yellow, purple, and clear white. Decrepitates on the application of heat.

SULPHATES OF LIME.

Do not effervesce with acid; softer than calcareous spar; yield to the knife and to the nail. Decrepitate with heat.

Compact gypsum.—Gypseous Alabaster. Massive. White.

Selenite: crystallized gypsum.—Crystals, six-sided prisms.

Fibrous gypsum.—Colour snow-white, translucent, prismatic.

Plumose gypsum.—In curls.

NITRATE OF LIME.—Deliquesces in the air.

CHAPTER IV.

EARTHY MINERALS CONTINUED.

MAGNESIAN MINERALS.

Business having obliged Mr. C. to leave home for a few days, the lessons were suspended. Meanwhile Mrs. C. brought out her stores, to exercise the skill of the students; and was gratified by the readiness they showed in trying and determining several carbonates of lime. Frank examined the marble chimney-pieces, and went with his mother into the church, to look at the monuments, and found several which he thought were of Lucullite. One or two ancient tombs were constructed of a species of stone, with shells, plainly to be perceived on the surface. His mother could not assist him in explaining the nature of the stone; and Mrs. C. being engaged with visiters, Frank did not attempt to trouble her on the subject.

When Mr. C. returned, his attention was directed to his garden and his farm. Frank took Helen's advice, and went with her to gather flowers.

The following morning, at breakfast, Mr. C. drew out some small parcels. "Hitherto I have been busy since my return from town," said he; "but I have not forgotten my young pupils. Open those papers, Helen."

Upon the first was written, "*Serpentine from the Lizard:*" upon the second, "*Cornish heath,*" *(erica vagans.)* In the third was a quantity of long, silky-looking fibres, which Frank called very stiff silk. Mr. C. then produced a piece of cloth, which he told them was woven with the fibrous mineral on the table.

"Is *that* a mineral also?" said Arthur. "What can it be made of? I should be afraid to say there is no lime in those fibres; for I have learned, at least, to be cautious how I make positive assertions."

"When I tell you this cloth is woven with the fibres of the mineral, and that it will not be consumed in the strongest fire, I think you will have some clue."

Helen smiled; but with the modesty for which she was remarkable, she was silent, though her brother hesitated, because Mr. C. had addressed him, and she thought that Arthur probably knew as well as herself.

"I have thought of it," exclaimed Arthur; "the cloth is made of *amianthus:* the ancients used it for wrapping the bodies of the dead, when they were laid on the funeral-pile to be burned; and Helen knew it likewise, but she never pushes in her knowledge: she is as pleased with my guessing right, as some would be that they answered before me."

"I perceive the good feeling that animates you both: that is the way to be happy. We have another mineral to examine yet. It is *serpentine:* the rock that chiefly forms the most southern point of England, called the Lizard Point. *Magnetic* iron ore is contained in it; and mariners often find the needle of the compass affected when they are near the Point."

"What a great magnet the Lizard Point must be!" said Frank: "I shall not forget *that*, I think."

"Turn your eye to the chimney-piece. The Mona marble has fine green waving streaks, which are serpentine and asbestus: the white part is lime. But let us withdraw to the study. I have taken out some minerals ready for you. Taste that white powder."

"*Magnesia*," said Helen.

"Very right; magnesia forms *part* of the minerals we are going to examine this morning. They take their name from this circumstance, and are called *magnesian minerals.* Magnesia,

even in small proportions, takes away the hardness and lustre of stones, and gives them a soft and *unctuous* or greasy nature. Green, of various shades, is a prevailing colour in these minerals. You have already seen red serpentine from the Lizard. This dark-green specimen is *noble* or *precious* serpentine: it yields easily to the knife; but the common variety, either red, or green and white, will scarcely give way to it. Serpentine generally scratches calcareous spar. Noble serpentine is cut into various forms. It was considered as an antidote to all poisons; and cups made of it were said to reject poisoned liquors, causing them to froth out. This mineral contains silex, clay, iron, and manganese, as well as magnesia: it feels rather unctuous, and is *amorphous*, or without regular form. All these specimens you see are shapeless masses. In connexion with serpentine, I will notice *Cornish heath*, of which I have brought you a specimen, Helen, from the stores of a botanical friend. It grows in profusion on the serpentine near the Lizard, but is never seen wild beyond the boundary of that district. I have understood that it makes a beautiful appearance when its flesh-coloured flowers are in full bloom. A magnesian soil, you must conclude, is quite essential to its growth."

"Feel that white piece of rock, Frank."

"It is a bit of soap, sir, I believe," said he.

"Put it into hot water: it will fall to pieces. You can cut it with a knife: you may write with it on this square of glass. It will dissolve in acid slowly, without effervescence. The mineral is *steatite*, or *soap-stone*. The next is also steatite, but not so pure. The more colour, either red or green, that is mixed with it, the less easily it yields to the knife. It is found in serpentine rocks. A Spanish variety is known to artists as *Spanish chalk*. The ancients used steatite to bleach linen: the Arabs, as a soap. What say you, Frank, to a piece of steatite for dinner?"

"Oh! now you *are* jesting," said Arthur.

"I do assure you, that several savage tribes eat a species of steatite, either alone or mixed with other food. It is part of the sustenance of the Ottomacks of the river Orinoco; and the natives of New Caledonia are known to make a similar use of it. However, I have none that will tempt you, probably; but you may not find this little cup so uninviting. It is formed of *lapis ollaris*, or *pot-stone*, which is frequently made into vessels: notwithstanding its softness, it is infusible, and is used for domestic purposes in Egypt and Italy. The mineral abounds in Scotland. The colour is greenish.

"Touch this soft, white mass with your

tongue: it adheres strongly: it will yield to the nail. Try an acid upon it, Arthur. There is no effervescence; but you may make it lather in water, like soap. The Tartars use it for washing the hair. In Turkey, tobacco-pipes are made of it. The name is *meerchaum*, or *sea-foam*."

"What a very pretty mineral it is," said Helen; "is there any found in England?"

"*Meerchaum* occurs in veins, in serpentine rocks in Cornwall. It contains much water, and is very hygrometric. *Amianthus* or *flexible asbestus* you have already seen: the four next are very nearly allied to it. *Asbestus* is much harder: the colour is greenish white, or grey; but it is soft and *sectile;* that is, capable of being scraped like slate-pencil."

"That is like a piece of wood," said Helen; "yet it shows fibres like asbestus. It seems very tough, but I can scrape it with a knife."

"It is called *rock wood*, or *wood asbestus*. There is also *rock cork*, of a yellowish white colour, which is porous, and will swim on water. *Mountain leather* is found in thin pieces, and is closer in its texture."

"I think the magnesian minerals are very amusing," said Arthur; "what a variety of curious specimens we have already seen, and there are still some more to examine. That which Helen has in her hand looks like asbestus."

"It is called *asbestiform tremolite.* When broken, the fracture or fresh surface is fibrous; the lustre is pearly: when pounded, and laid in hot coals, it gives a green light. This *glassy tremolite* is very pretty, with its long, shining, needle-like prisms. All the varieties yield phosphorescent sparks, when scratched by a needle in the dark: they are flexible and brittle. Tremolite is distinguished by its white colour from *actinolite*, which is light green. These minerals are found in our own country, but take their name from Tremola, a valley in Switzerland."

"Tremolite and actinolite are some of the first minerals that I shall buy," said Helen. "I admire this *glassy actinolite:* the pearly green lustre is beautiful."

"*Talc*," said Mr. C. "is known by its soft, unctuous touch. It is white, green, and sometimes light yellow. It yields to the nail, but does not effervesce with acids. That mass, of a dull white colour, is compact talc: the other, composed of delicate green scales, with a pearly lustre, is *earthy talc* or *nacrite:* it will crumble in the fingers, or is *friable.* Talc bears some resemblance to *mica:* I shall notice the difference at a future lesson. Gypsum figures receive a flesh colour by being rubbed with talc."

"This is a piece of compact limestone," said Arthur: "it is hard enough for it."

"I am not of your opinion," said Helen: "we have quite left calcareous minerals; and I rather think this is *French chalk*, which I have seen workmen use for drawing lines. A carpenter told me they will remain unaltered even under water."

"When *talc-slate* comes out of the rock," said Mr. C. "it is soft and unctuous. The colour is greenish grey; the surface is striated: it is hardened in the fire. Write with that edge on the glass, and breathe upon the letters. Now they are visible. Can you recollect any other character, Helen?"

"It is *sectile*," said she; "for it is scraped to a powder before it is used for taking out spots from silks, that are caused by any thing greasy."

"Your talc-slate is also called *indurated talc:* vessels are made of it, capable of bearing the fire."

"What a fine green colour this powder has," said Arthur; "and here is a mass of it."

"That is *green earth.* The powder is to be obtained at the colour-shops, and is often called *terra verte:* it is the *mountain-green* of water-colour painters.

"These paler green scales, on a piece of rock, is *earthy chlorite.* Neither of these last minerals contain much magnesia.

"*Diallage*, *nephrite*, and *axe-stone*, you will

meet with at the British Museum. Nephrite is used for the handles of military weapons, in Turkey. Axe-stone is formed into hatchets by the New Zealanders. Some small specimens have been found in Cornwall."

"We shall have some very pretty minerals to examine again," said Helen; "but I am afraid we should not remember the names of them without our useful list."

"Here is the list of magnesian minerals. I hope you take care of the others," replied Mr. C.

MAGNESIAN MINERALS.

Serpentine.—Scarcely yields to the knife; scratched by fluor spar.

Precious or noble serpentine.—Yields easily to the knife; colour dark green.

Steatite or soap-stone.—Yields to the knife; falls to pieces in hot water; leaves a white streak on board; writes on glass; soluble in acids.

Pot-stone or lapis ollaris.—Soft, but infusible; colour greenish.

Meerchaum or sea-foam.—Yields to the nail; adheres to the tongue, does not effervesce with acids.

Asbestus.—Soft, unctuous, sectile; colour greenish white, or grey.

Amianthus, a variety of asbestus. *Flexible asbestus.*—Fibrous, silky, elastic; indestructible in the fire.

Wood asbestus. Rock wood.—Tough and sectile; resembles wood; colour brown; adheres slightly to the tongue.

Rock cork.—Is found in masses; structure porous; swims on water.

Mountain leather.—Occurs in thin pieces.

Asbestiform tremolite.—Soft and brittle; fracture fibrous and silky.

Glassy tremolite.—Fibres harsh to the touch; the mass intersected by transverse seams; colour white, tinged with pale red.

Glassy actinolite.—Colour green, lustre vitreous, pearly; in parallel needle-like crystals; harsh to the touch; bladed.

Talc.—Yields to the nail, soft, unctuous; colour dull white.

Earthy talc, or nacrite.—Friable; composed of green scales.

Talc slate, indurated talc, or French chalk.—Soft to the touch; sectile; surface striated; writes on glass.

Green earth, or terra verte.—Very soft, earthy, dull green.

Earthy chlorite.—Composed of green scales.

Nephrite.—Colour light green; texture compact; scratched by quartz.

Axe-stone.—Colour dark green; scratched by quartz.

CHAPTER V.

EARTHY MINERALS CONTINUED.

SILICEOUS MINERALS.

ANOTHER delay took place in Mr. C.'s lessons to his young guests, a gentleman having arrived on a visit for a few days.

Arthur complained to his mother that Mr. King would very much hinder their progress; and that Mr. C. himself seemed to forget that such a study as mineralogy was known to him. "They only talk of politics, building, and ground-rents," said he: "I cannot understand much about either, so I would not walk yesterday."

Arthur's mother saw Frank at play near the hall-door, and called him to her. "What are you doing, my dear?"

"Building, mamma. I have oölite, which is Portland stone; and Carrara marble, Mona

marble, Kilkenny and Derbyshire marble. I shall pave the front with free-stone; and I have a great mind to roof my house with Yorkshire stone, instead of slates or copper."

"But where are all these materials to be procured?"

"I brought a number of pieces home last night. Helen and I went with Mr. King and Mr. C. to look at the new seat that is building at Holmes Wood; they were so kind as to bring a few fragments for me, and Helen's bag was full. Mr. King knew all the marbles and stones; and when we sat down to rest, he showed me the different nature of the stones, and explained why one sort was preferred to another."

"But he did not tell you that houses were roofed with stone or with copper, I know," said Arthur, who began to think he had been rather too hasty in accusing the architect of ignorance.

"Mr. King said, that in some parts of Yorkshire, one kind of sand-stone is cut thin enough for roofing. He showed me some Yorkshire paving-stone, which I have; and he told us that copper, in plates, is used for covering houses in Sweden: and then they talked a great while about the lightest material for roofing."

"That free-stone is another sort of oölite, I suppose," said Arthur.

"No, Arthur, it is a sand-stone, indeed; and

is called *free-stone* because it works easily under a tool, when it is moist. Mr. C. says we shall begin to learn the minerals, that have a large portion of silex in them, at the next lesson."

"I will come and look at your stones with the magnifying glass," said Arthur.

"Oh! do come, Arthur," said Frank, much pleased to show him something new; "and then I know you will stay and help me to build."

"A young mineralogist may learn from an architect," said his mother, with a significant smile, as they left the room.

Arthur took care to attend to Mr. King's conversation while he remained at D——. Helen's unobtrusive manners always pleased.

Mr. King observing that she gathered and examined plants, described to her a very small moss, *(weissia calcarea,)* which is known to indicate the best kind of chalk; and in their search along the sides of the chalk-pits, they had the pleasure of finding it. Helen searched for the moss in "English Botany," and found it under the name of *bryum calcareum.*

After Mr. King's departure, Mr. C. proposed to renew his instructions; and having questioned each of his pupils, expressed his approbation at the accuracy of their answers.

"We are now," said he, "to become acquainted with the most abundant substance in nature. The sand of the sea-shore, the mighty mountains, hard stone that is cut from the quarry, many beautiful gems, and gravel and pebbles, and flint in beds of chalk, are all chiefly formed of *siliceous earth*."

"I am glad to hear of gravel-stones," said Frank, "because I shall soon know what the stones are made of that I have so often taken from heaps of gravel: they are such curious things, I wish we had them here."

"Open that box, which has *flint* written on the lid."

"Some of these flints are just like mine."

"Let us examine them," said Mr. C. "Flint is composed of siliceous earth, a very little iron, and clay or *alumina*. It will not melt or fuse in the fire, but whitens and becomes opaque. When it has been exposed to air and moisture, it assumes a yellow, and also a red colour, like those in the box, and is called *ferruginous* flint. Such stones are found in gravel-pits. These grey flints are found in layers, in the stratum of upper chalk. It is often tuberous: sometimes it occurs in rounded masses, which, on being broken, are hollow, and the cavity is occasionally found full of very pure chalk: sometimes a smaller flint is contained in it."

As Mr. C. spoke, Frank took up a rounded flint, which came apart in his hand, (having been previously broken.) It was hollow: the cavity was filled with quartz crystals. "How very curious!" said Arthur. "This must be something very rare."

"Not at all, Arthur; I have seen masses of these crystals among the broken flints that are used for repairing the roads. *Nodules*, or rounded masses of chalk-flint, sometimes contain the remains of sponge. The cavities are also filled with a siliceous mineral, called *calcedony*. Some flints have impressions of shells upon them. You must observe the *fracture* of flints: it is *conchoidal*, or hollowed in some parts like a shell. This is the nature of the substance. The *impression* is made by the shell itself. Masses of flinty pebbles are often found in the gravel near London, held together by oxide of iron: they are very heavy. Here is an example. You may chance to see them in your walks. The masses are a coarse conglomerate."

"Shall we find these flints with quartz and the other minerals near London?" asked Arthur.

"Undoubtedly, if you will go to the places where they are to be found. I hear that your mother has friends in the neighbourhood of Greenwich: the pits in that quarter will be very accessible. Take a specimen of these various

kinds of hollow flints, to assist you in recognizing those you may find. I fear your mother will find these stores rather troublesome, if you are not careful to arrange them neatly."

"We have a little room for ourselves," said Frank, at home. "I will set the flints all in order, with their proper names, and where they come from, if Arthur will write tickets for them in his best hand."

"Now let us return to the minerals on the table," said Mr. C. "I think you will be pleased with that pebble from a heath near N——."

"Is it painted?" asked Helen: "here is the figure of an animal's head, and here is another as curious."

"They are entirely natural," said Mr. C. "and are flints, or siliceous pebbles.

"Curious pebbles are to be met with in Charlton sand-pits, with regular stripes. *Ball-like sand-stone* with oxide of iron, and pure white silex in the centre, is likewise to be found there.*

"*Chert* is an earthy variety of flint: it is also called *hornstone*. The colours of chert are blue, grey, yellowish, greenish. It is found in the sand under chalk, often changing into *chalcedony*.

* Sowerby's Mineralogy.

The change also from flint to *chalcedony* is almost imperceptible. Its colours are grey, white, yellow, and bluish grey. The masses often have a bubbled or *botryoidal* appearance. There are large specimens in the Museum. *Chalcedony* is infusible, translucent, harder than flint. The cavities of chalky flint are often *lined* with this mineral, and filled with quartz crystals. Look at the surface of this flint: there are small, semi-lunar, white marks upon it. Those are chalcedony: there is more of it. In this mass of flint you may perceive little bubbles of blue-grey chalcedony, filling up the cavity. Sometimes calcareous spar collects with it, but that is less common. There is a black-brown coloured variety that appears deep red when held up to the light.

Crystallized silex is called *quartz* and *rock-crystal.* It is infusible, strikes fire with steel, stratches glass, and is insoluble in all the acids except the fluoric. It is harsh and meagre to the touch. These characters are common to every variety of quartz. It also resists the point of a knife, when forcibly drawn over the surface. Two pieces rubbed together become phosphorescent, and emit a peculiar odour. *Iron pyrites* is a very common attendant upon quartz. The form of the crystal is commonly a six-sided prism, terminated by a six-sided pyramid. Here is a *Cornish diamond*, or specimen of vitreous

quartz. The six sides of this pyramid are very easily counted."

"Pray tell me what *vitreous* means," said Frank.

"Vitreous means glassy, clear, white, resembling glass. Some quartz is coloured by iron: here is a specimen of it from Bristol, of a red-brown colour. Quartz upon *galena*, (an ore of *lead*,) is dark grey: when the crystals are very small, the quartz is called granulated. *Onyx* is a variety of chalcedony: it shows layers of brown, black, and white colours. Some mineralogists call it a striped carnelian."

"These pebbles remind me of flint," said Arthur, "but they look too transparent."

"They are *carnelian:* those specimens came from India, but carnelian pebbles may be found on our own shores. There is a kind of pebble occurs on the beach at Rottingdean, near Brighton, which, on examination, proves to be agate. Small masses of blue-grey chalcedony are also found among the flints there. Go to a little distance. What do you think of this picture?"

"It is a castle," said Arthur, "I see the fortifications; but what connexion has this picture with minerals?"

"The slab is a polished specimen of *fortification agate:* the colours are produced by intermixtures of various siliceous minerals, as car-

nelian, jasper, and quartz. This *mocha stone* is another variety, called *moss agate*. *Agate* strikes fire with steel. It is quartz, with jasper and carnelian; chalcedony and opal."

When these had been sufficiently admired, Mr. C. produced the *Lydian stone*, which he told his pupils was used as a touch-stone, to try the purity of gold and silver. "Flint," said he, "will serve as a touch-stone for silver. Bring a grey flint, Frank, and try these silver coins: if they are good silver, they will leave a white line on the flint, where they pass over it."

The silver proved good, and Frank put aside the flint, to show his mother "the excellent way," as he termed it.

"We must not omit the beautiful *opal*. Here are specimens—milk-white, yellow, and greenish: it is half transparent. Hold this white fragment to the light: it now appears pale yellow. Opal is never found crystallized: it is infusible, and is soluble in all acids except the fluoric. That is right, Helen, try an acid upon it: always ascertain the nature of a mineral if you can. It will scratch window-glass."

"Several precious stones may be numbered amongst siliceous minerals. *Precious garnet* is a dark red colour: it is harder than quartz. *Cat's eye* has a yellowish lustre, and when cut, resembles the eye of a cat in the dark: it is

found at Ceylon. *Amethyst* is of every shade of violet colour: it owes its tint to iron."

"But the diamond," said Arthur, "that hard stone surely belongs to the flinty minerals?"

"There is no flint in the diamond, Arthur."

"Is this marble," said Helen, "with large pebbles of different colours?"

"No, the slab is called *pudding-stone:* it is composed of pebbles, held together by quartz and *jasper*. It comes from the neighbourhood of St. Albans."

"Pray show me jasper," said Arthur.

"Here are three kinds. *Common jasper*, which is found in beds in mountains; it is deep red, sometimes yellow; dull, opaque, conchoidal, or even, in different pieces; it is scratched by quartz, and never shows a crystalline structure. The next is *Egyptian jasper:* it is found in great abundance near Cairo. The third is *striped jasper*, grey, yellow, or green and red: this will take a fine polish."

"We shall soon come to granite," said Helen; "I know that; it is so common in the streets of London.

"One of the principal minerals that form the rock called granite is before you. It is *felspar*, or *feldspar*, one of the most abundant of simple minerals. It will not effervesce with acids, yields with difficulty to the point of a knife, it is

not so hard as quartz, and is fusible. The most common colour of felspar is flesh-red, white, yellowish, not often green or blue. This variety of felspar, called *adularia* or *moon-stone*, is very pure: it is like mother-of-pearl; a beautiful pearly light may be seen, if it is held in one direction. Let the light fall on this grey-looking slab."

"Oh, how beautiful!" exclaimed Helen: "what a variety of colours—green, blue, red, violet! What is the stone?"

"*Labrador felspar*, of which here are several pieces: take one to add to your collection, and try if it is to be scratched by quarts. We will now examine the mountain rock, *granite*, which is composed of *felspar*, *mica*, and *quartz*: another mineral, called *cleavelandite*, is sometimes mixed with these. Cornish granite has the black plates or *laminæ* of *mica* sparingly mixed: other varieties are smaller grained, and more dark. Waterloo bridge is built with granite. London and Westminster bridges are constructed of *moor stone*, which is chiefly felspar. The crystals of this mineral are very plainly to be seen, imbedded in the granulated stone, especially after rain, where the surface is decayed by the action of the atmosphere."

"Is this yellowish mass granite, with white spots and hollows filled with a red-looking earth?"

"That is the *burrh stone*, or cellular quartz: the cavities are filled with a ferruginous clay earth. It comes from France, and the best mill-stones are made of it. That Derbyshire mill-stone is not half so highly esteemed. I must not forget to show you *Druid sand-stone*, which is silex and pebbles forming a *brescia*, in the manner of pudding-stone. The Druids held it in great estimation, and used it as a building-stone. Amulets were formed of the pebbles. Masses are found in the shingle beds on the shore at Brighton. Very large blocks are to be seen on the Downs of Wiltshire, where they are called *Grey Weathers*. Stonehenge is of this siliceous or quartose stone. The white variety, when broken, looks like loaf-sugar."

"Is not this mass petrified wood?" asked Arthur: "here are all the fibres."

"The woody texture is preserved, but the vegetable matter is quite gone. The mass is *horn-stone:* that piece is grey, it is found of a yellow and several other colours. It is difficult to distinguish *horn-stone* from compact felspar. The colours are deep red, grey, or green. Felspar is fusible, horn-stone is not. You like a sharp knife to cut your pencil with, Helen."

"Yes, and I wish mine were sharper."

"There is a slip of *whet slate*, or *Turkey hone*, for the purpose; and another species, called

Charnwood forest-slate. The hones from Turkey are the most valuable. They are to be seen in the ironmongers' shops in this form, and also set in a frame. Razors, penknives, and other steel instruments, are sharpened on them. Whet-slate is called also *novacolite.* Our next minerals are remarkably light; will float on water; they will not effervesce with acids, nor yield to the knife. The first is *polishing slate.*"

Arthur rather hastily pronounced that the other was asbestus, from the silky appearance of the surface; but Helen, always mindful of the character of the division they were examining, reminded him that *siliceous* earth, not *magnesian,* prevailed most in the present specimens.

"Rub out this written word with the edge of the mineral," continued Mr. C., "and write again in the same place: it will serve the purpose both of knife and pounce; indeed, *ponce* is the French name for it: we term it *pumice.* It is easily procured at colour shops. In the form of powder, it is useful for polishing metals, soft stones, and glass. Shells that have been moistened with a strong acid, will be improved by rubbing with powdered pumice."

"I shall try it," said Helen; "but has tripoli any connexion with pumice? we have often used the powder."

"*Tripoli* is also a siliceous mineral; it is soft,

easily broken, rough to the touch, coarse-grained, and earthy: it does not adhere to the tongue. *Rotten-stone*, which is found in Derbyshire, differs much from tripoli; it is darker than tripoli. I shall show one more mineral, and then it will be proper to conclude this lesson."

"I know the smell of this red, chalky substance," said Helen.

"Very probably you may, my dear: it is a common ingredient in tooth-powder. *Bole*, which is the name of it, has less silex in its composition than tripoli contains, but chalk forms no part of it. The fracture is conchoidal: it falls to pieces when put into water, with a crackling noise; air-bubbles also issue from it, whilst it is immersed. *Fuller's earth* is chiefly composed of silex: it falls to pieces in water without noise, like bole. Very large beds of this earth occur in various parts of the country. Do not fail to repeat your examination of the minerals I have been showing to you. You must perceive how much less we have used the acids as tests for siliceous minerals; but quartz, felspar, and window-glass, have been very much needed. There is your list, to assist your memory."

SILICEOUS MINERALS.

Flint.—Colour various; fracture chonchoidal; strikes fire with steel.

Chert.—Variety of horn-stone; the nodules often afford quartz crystal.

Chalcedony.—Grey, white, bluish, and yellow; translucent; gives sparks with steel.

Quartz.—Gives sparks with steel; resists the point of a knife; scratches glass.

Rock crystal.—Perfectly transparent; crystals pyramidal and six-sided.

Onyx.—Striped *carnelian*, or, according to some, *chalcedony*.

Carnelian.—Red, yellow, or white; strikes fire with steel; scratches felspar.

Fortification agate.—Marked with angular lines.

Moss agate.—With moss-like fibres.

Lydian stone.—Grey or black, with minute veins of quartz; scratches felspar.

Opal, (precious.)—Pale orange; scratches window-glass; softer than felspar.

Garnet, (precious.)—Red, scratches quartz. *(Common,)* brown, scratches felspar.

Cat's eye.—Remarkable for a play of reflected light. (Quartz with amianthus.)

Amethyst.—Violet, coloured by iron.

Pudding-stone.—Composed of pebbles imbedded in siliceous or clay paste.

Jasper.—Red, smooth, dull; fracture chonchoidal; gives sparks with steel; scratched by quartz.

Felspar.—White or red; compact or friable; scratches glass; is scratched by quartz.

Adularia.—Variety of felspar; scratches quartz feebly; gives a pearly light.

Labrador spar.—Surface grey; exhibits various colours; is scratched by quartz; scratches window-glass.

Granite.—Composed of vitreous quartz, mica, and felspar; either white or red.

Moor stone.—Chiefly granulated felspar, with crystals imbedded.

Burrh stone, (vesicular quartz.)—The cavities filled with the red clay, marle.

Druid sand-stone, (grey weathers.)—Exceedingly hard; quartz and pebbles.

Horn-stone.—Grey or green; shining; scratches felspar; fracture conchoidal.

Whet slate.—A fine-grained variety of clay slate; yields to the knife.

Turkey hone.—Variety of the preceding; soft to the knife.

Polishing slate.—Colour white or yellow; soils strongly; swims on water; used for polishing stones and marbles.

Pumice.—Porous, vesicular, fibrous, fusible; colour grey; rough.

Tripoli.—Colour light brown; softer than fluor spar; yields to the knife.

Rotten-stone.—Fœtid when rubbed; yields to the knife.

Bole.—Red or yellow; emits globules of air in water, and falls to pieces.

Fuller's earth.—Earthy; falls to pieces in water; polished by the nail, and yields to it.

CHAPTER VI.

EARTHY MINERALS CONTINUED.

SILICEOUS MINERALS AND BARYTES.

"I THINK, Frank," said Mr. C., the next time he invited his young friends into his study, "you can furnish us with a few examples of sand-stones."

"Oh yes!" replied Frank, "I have all my specimens ready."

"I shall call for them in due time: now come and look at *mica*. Here are gold, brown, black, silver, and green plates, and spangles."

"It looks like talc," said Arthur, "but it has not the unctuous feel of talc; and this mica will scratch glass. How easily the plates bend! That black mica we saw in Cornish granite."

"*Mica* or *Muscovy glass*," said Mr. C., "is an article of trade in Siberia, where it is used instead of window-glass. The elasticity of mica distinguishes it from talc; the edges will scratch quartz and glass; you can write upon it with a pin. Mica may be torn apart."

"I should have taken these gold-coloured spangles for real gold," said Arthur.

"As many persons have done, to their own injury. There is a part of the hill at Malvern, called 'The gold mine.' A former owner, who supposed the mineral was really gold, put himself to much expense in order to raise the substance, before the mistake was discovered."

"What a disappointment!" said Helen. "Is there any certain means of distinguishing gold from yellow mica!"

"Yes, Helen, as you will know when we turn our attention to the metallic minerals. The next dark mass is *basalt:* it occurs in the coal districts. In the vicinity of Birmingham, and at Dudley in Staffordshire, the hills are formed of basalt. It bears the name of *rowley rag* in that quarter. The streets of Birmingham are paved with it. The hexagonal columns in Ireland, are remarkable specimens of basaltic rocks, called the *Giant's Causeway.* The fracture is conchoidal, the lustre glimmering, owing to the very small black crystals in the mineral. It is opaque, brittle, not easily frangible, scratches glass, and strikes fire with steel: cavities in the rock are often filled with calcareous spar. *Clay slate*, or *argillite*, is a widely-extended mineral, forming beds in the cliffs of Cornwall, and in the mountains of Westmorland. The colour is bluish

grey: slate is sonorous when it is struck by a hard body. Slate quarries afford us many varieties. *Talcose slate* is a silvery grey substance, unctuous to the touch. *Mica slate* is composed of quartz and mica: it is not common in this country, but occurs sometimes in the Scottish mountains. *Wackè* is said to be allied to basalt: the colours are reddish, greenish, grey-brown, and even black. It is usually rather soft, and resembles indurated clay, with a ferruginous appearance and slaty structure. Here is a specimen. *Prehnite* is a more interesting mineral, but in appearance only: it will neither afford us roofing slates, nor writing slates. The crystals are very pretty, diverging from one point in a fan-like form: they are often green. Prehnite is scratched by quartz; scratches glass with ease."

"This shining, smooth, black substance, is *tourmaline:* it also occurs green, blue, brown, and red. The crystals are striated. It becomes electrified by gentle heat. The next is common *schorl:* it forms entire rocks. The colour is velvet black, and shining: it scratches quartz. These little grotesque figures come from China, where they are cut into these forms. The stone is called *agalmatolite,* or *figure stone:* the colours are flesh-red, green, with veins of brown or blue. You may frequently see the figures in

shops. It is considered a variety of steatite, but it contains no magnesia; and silex is the chief ingredient in the mineral. *Zeolite* is a very pretty mineral. The colours are white, red, or green: it intumesces under the action of the blow-pipe. Now, Frank, bring forward your sand-stones. You found some mill grit also, the other day. Of *iron sand* and *green sand* we have a sufficient supply. I have some of the coloured, as well as the fine white sand, from the Isle of Wight. Flexible sand-stone is rare."

"How lively the colours of these sands are!" said Helen: "red, green, pink, brown, yellow. They will scarcely hold together."

"Yet, feeble as they appear," said Mr. C., "they are formed of a very hard substance, I mean, quartz; and in a loose state, are capable of effecting the destruction of vegetable and animal nature. Grains of quartz form the sands of the deserts, and the sea-shores. Travellers, and even whole caravans, have been overwhelmed by immense columns of moving sands, which traverse the deserts of Africa. In our own country, a *sand-flood* is little less destructive than the fury of the sea. In the year 1769, a sand-flood occurred in Aberdeenshire, which overwhelmed a large district. The wind catches the sand, and finding no impediment, pours it in one continued

stream over the adjacent country, burying houses and trees in its ruinous course. One part of the Norfolk coast is liable to similar disasters."

"How frightful it must be!" said Helen. "Cannot the progress of the sand be stopped?"

"Not while the wind continues. A barrier, however, has been given, by which the sands may be permanently fixed. Indeed, it was the unwise removal of this simple yet powerful restrainer of the moving sands, that principally caused the inundation. I will show you a specimen, and I think you will not consider one unworthy a first place in your collection of plants."

Helen opened a long paper parcel, on which was written, *arundo arenaria, sea mat-grass, marram, English bent star;* a tall plant, with woody roots and grassy leaves, the long stalk bearing a thick spike.

"Can this reedy grass be the barrier you mean, sir?"

"And a most effectual one. The plant grows only in pure sand. A single plant will collect and fix the sand around it into a hillock, which increases to a large mound, and thus forms a barrier to the waves. As the sands fix, the plant disappears; the great end for which it is apparently placed there being effected. It is this plant that binds the sands on the shores of

Holland, and is the chief defence of the country against the encroachments of the sea. *Elymus arenarius*, *sea lyme-grass*, is another most valuable plant for the same purpose, and is abundant on the coast of Norfolk, where it lends its aid in resisting the waves of the German Ocean. So far back as the reign of Elizabeth, an act was passed, prohibiting the use of the roots as fuel; and another to the same effect, in the time of George the Second*."

"What an interesting plant!" said Helen: "I shall prize this specimen; and I will write down the account we have heard, lest I should forget any part of it."

"Do so, my dear: it is one, among the numerous instances, of the wisdom and beneficence of the Creator, in whose hand a feeble reed, that bends under the blast, is converted into a rampart, to which man securely trusts."

"What name do the Dutch give to the plant?" asked Arthur.

"In Holland it is called *helm:* in the Highlands of Scotland, it is known by the name of *murah.* Destructive as we find these sands may become, they nevertheless afford a most useful material as building-stones of various kinds, and in combination with an alkali, the

* Knapp's British Grasses.

substance greatly contributes to our convenience and to our daily comforts. It is ornamental as well as useful."

"I cannot think how silex can be ornamental," said Arthur, "unless you refer to those fine transparent crystals that might truly adorn a mantel-piece. But how does it increase our comfort?"

"Indeed!" said Mr. C. "What renders our apartment at once airy, warm, and light, but *glass?* What is more beautiful than glass of all forms, sparkling in the light, and coloured with various hues, that we see in the shops in London? What is that little magnifier, that has lent you such powerful aid in discovering the hidden beauty of a moss, and made you acquainted with the unseen wonders of a stone?—Quartose sand and soda melted together."

"How foolish," said Arthur, "that I could not recollect glass! But how is glass coloured so finely?"

"Generally by the metals. *Iron* gives a green colour; *lead*, yellow; *cobalt*, blue; *gold*, red; and *manganese*, purple. The fine white and pure sea-sand from Lynn in Norfolk, and the Isle of Wight, is in great repute for glass-making. The process will amuse you, when you are acquainted with the various metallic oxides that are used to colour the material."

"What an admirable invention!" said Helen.

"If the old account be true, it is not the *invention* of man, although it shows the advantage to be gained by *observation*. It is said, that some sailors having kindled a fire of dry sea-weed on the sandy shore, perceived that the sand had run into a clear transparent body, in the place where the fire had been made. The sea-weed contained soda: you know where the other ingredient was?"

"Yes, the sea-sand was silex, and being melted by heat, they formed the glass."

"The *sand-stones* will conclude the division of siliceous minerals. Are you acquainted with any other earthy minerals?"

"With two other divisions—the *magnesian* and the *calcareous*."

"There are several kinds of sand-stones," continued Mr. C.; "the finer sort, called free-stone, or siliceous sand-stone, contains silex and mica: it cuts freely in all directions, and is used for architecture. *Micaceous* sand-stone has a slaty structure: it contains some clay. *Mill-stone grit* is a coarse-grained sand-stone, consisting of siliceous particles of various sizes, often large enough to give the rock the character of a pudding-stone. It is harder than the other sand-stones; the colour is red, or light grey; the parts are cemented by clay. When the sand-stone is very hard, it is

called *grindstone:* a bed of stone of this variety occurs on the south of Newcastle, at Gateshead Fell, above sixty feet in thickness. Great Britain, and even the continent, is supplied from this place chiefly. The softer parts of the bed are used for filtering stones."

"I perceive," said Helen, "that Frank's specimens answer to the description; but you mentioned these sand-stones as *rock.*"

"They do indeed form a series of very extensive beds, beneath the equally wide-spread *coal* formation of Derby, Nottingham, and Staffordshire; extending to the northern border of the island in Cumberland, Northumberland, and Durham. Can you remember the name of the rock in which gypsum is met with?"

"*Red marle*, or new red sand-stone."

"The mass before us is *old red sand-stone*, coarse grained and micaceous; the colour is usually dirty iron-red, or dark brown; it contains quartz, felspar, and mica. When clay beds accompany this rock, it often affords a very fertile soil. The summits of mountains of this formation, Helen, are usually covered with *mosses.*"

"What part of England is noted for old red sand-stone?" asked Helen.

"It rises into lofty mountains, in the counties of Hereford, Monmouth, and Brecknock; but

we have entered the bounds of geology. One more division will conclude our study of the first class, which, you will recollect, is composed of *earthy minerals*. I will mention here an earthy mineral, which, from its great weight compared with others of the class, has been named *barytes*, from a Greek word, signifying *heavy*. *Sulphate of barytes*, or heavy spar, is crystallized in a tabular and prismatic form; large stellated masses are found in the blue clay in the Isle of Sheppy; they resemble calcareous spar. The *carbonate* is not so common. Here is a mass of clay with the crystals forming upon it; and a specimen of the tabular form, with white, opaque crystals. The base is metallic. *Cawks* and *bolonian-stone* are sulphates of barytes."

SILICEOUS MINERALS.

Mica.—Elastic; yields to the knife; smooth, but not unctuous.

Basalt.—Scratchs fluor-spar and glass; breaks with difficulty; yields to the knife.

Argillite, (clay slate.)—Yields to the knife; blue or grey.

Talcose slate.—Unctuous; silvery grey.

Mica slate, (micaceous schist.)—Texture slaty, with garnets often imbedded.

Wackè.—Texture slaty; rather soft; colours grey, greenish, brown.

Prehnite.—Scratches glass with ease; is scratched by quartz; greenish.

Tourmaline.—Black, smooth, striated; crystals in prisms; scratches quartz with difficulty.

Schorl.—Colour velvet-black; vitreous; scratches quartz.

Agalmatolite, (figure stone.)—Allied to serpentine.

Zeolite.—Intumesces; colour white, red, and green.

Flexible sand-stone—From Brazil.

Sand-stone—Micaceous sand-stone; slaty structure. *Siliceous,* chieflyquartz.

Mill-stone grit.—Coarse grained; grey or red; often vesicular.

Red sand-stone.—Iron-red or dark brown; coarse or fine-grained; micaceous.

Sulphate of Barytes.—Heavy spar; yields to the knife; decrepitates; often white, opaque, tabular.

Stellated.—Crystals prismatic; specific gravity above 4.

CHAPTER VII.

EARTHY MINERALS CONTINUED,

ARGILLACEOUS MINERALS.

"I do not expect so much pleasure from the minerals of the clay division," said Helen, "as I had from those of the calcareous and siliceous kinds."

"Do not give way to prejudice, Helen," said Mr. C. "I shall show you *argilla*, or, as it is also called, *alumina*, in very beautiful forms. Like lime earth, it is found to contain a metal. The plastic principle of all clays is the *alumina:* clays, however, contain much siliceous earth. It is the character of clay to become *plastic* or kneadable with water. Common brick clay may be polished, by rubbing the nail upon it. It is often mixed with sand and iron. When the former prevails, it is fit for building bricks, but too much iron causes them to harden in burning, when they become useless masses, called *clinkers*. *Potter's clay* is blue, sometimes ash-grey; it

feels unctuous and smooth. They are all before you. The other specimen is the London blue clay: it is very tough, and sometimes partakes of the nature of marle, which contains calcareous earth; the clay will then effervesce with acids. *Alumina*, or argillaceous earth, is an ingredient in most soils. *Loam* is the base of fertile soils. *Marle* is employed to enrich poor soils. Some marle is calcareous, and is then called *calcareous marle*."

"Has that old picture any connexion with clay?" asked Helen: "it seems the view of an old ruined castle, with the walls and ramparts half destroyed."

"On a nearer examination the illusion will vanish," said Mr. C., "and nothing will be seen but irregular marks. This is *Florence marble*, a compact marle, from the vicinity of the Arno. Our own *Cottam marble*, which is found near Bristol, is another curious formation of marle stained by iron. It occurs in broad slabs; the top has lines resembling the sky, in drawings; the lower part is like water, one might fancy that is a boat, and the cliff seems hung with ivy. Here are Brazilian and Scotch *topazes*, or *fluate* of *alumina*. You have met with the fluoric acid and *lime*."

"Oh yes! *fluate* of lime, the beautiful fluor-spar."

"These Scotch topazes, or *Cairngorum stones*, so called from the mountain in Aberdeenshire where they are found, are a yellow-coloured rock crystal, which resembles the real topaz. *Phosphate of alumina*, or *wavellite*, is a beautiful mineral. It often occurs in a botryoidal form; the protuberances are white or pale green. Look at those fractures with the glass; the crystals diverge from the centre in a fan-like form. It scratches felspar. It is also called *hydragillite*, from the great proportion of water that the crystals contain. *Corundum* will prove to you how hard an aluminous mineral may be, that is nearly all argillaceous earth. It is of various colours. Take a specimen of that yellow-white variety; it is sometimes red-brown. Corundum scratches quartz with ease. *Sapphire* is perfect corundum. The colour of the crystals is blue of various shades, sometimes red, white, or greenish-yellow. *Emery* is nearly allied to corundum: it is extremely hard, and will scratch any stone but the diamond. It is found in masses in mountains: the colour is blue grey. That is *coarse emery:* powdered emery on paper is well known for domestic purposes; with oil, it polishes metals."

"What a beautiful stone!" said Arthur, as Mr. C. took out a specimen of *lapis lazuli*, or *azure stone:* "it looks rather like *ultra marine in colour.*"

"And these gold spots upon the surface," said Frank, "look so very fine."

"Those spots are nothing more than iron pyrites," said Mr. C., "which often are associated with the mineral. *Azure stone* loses its colour with nitric acid. The term *lazuli* is derived from the Arabic word *azul*, heaven, the blue tint being sometimes the colour of the sky. Persia, China, and Bucharia, afford the stone.—Our lesson has been short this morning, but it will be best to defer entering upon the second of our classes till to-morrow. I ought to have told you that *ultra marine*, a beautiful blue colour, is prepared from azure stone. It is said to have received that name, from having been brought beyond sea."

ARGILLACEOUS MINERALS.

Potter's clay.—Plastic, unctuous, smooth; yields to the nail.

Loam.—Varies in quality and colour.

Marle.—Argillaceous, calcareous, or bituminous.

Florence marble.—Compact marle with irregular marks.

Cottam marble.—Marle stained by iron.

Topaz.—Scratches quartz with ease; colour yellow.

Wavellite, or hydragillite.—In round balls; crystals radiated.

Corundum.—Colour green, grey, or red; scratches all minerals but the diamond.

Sapphire, (perfect corundum.)—Blue, sometimes colourless.

Emery, (granulated corundum.)—Colour blue-grey; fracture uneven; glistening.

Azure stone, or lapis lazuli.—Loses its colour with nitric acid; *frequently* veined with iron pyrites.

CHAPTER VIII.

CLASS II.—COMBUSTIBLE MINERALS.

Combustible with or without flame, and (except the diamond) yield to the knife.

"WHAT an odd collection there is on the table to-day," said Arthur to Helen: "I just looked into the study, and there were coals, pitch, sulphur, something in a phial, and a diamond: would you think it? I believe it is only placed there to try our skill."

"But are you sure that you saw a real diamond?" said Helen: "rock crystal is very clear and beautiful. Mamma says she has some Bristol stones that are like diamonds; and I know they must be *quartz*."

"Very true, Helen," said Mr. C. who had entered the room unperceived; "but my diamond will cut your quartz, or any other mineral, for it is the hardest of substances."

"How can the beautiful diamond in any way

agree with common coal and sulphur? both which will burn, I know."

"Because," replied Mr. C. "the diamond is a combustible substance; and if it is enclosed in iron, and subjected to a degree of heat that will melt copper, it vanishes and is converted into carbon. In pure air or oxygen gas it burns with a brilliant light. Let us go and examine a rough diamond. The colour of that before you," continued Mr. C. "is pale grey. The diamond is also found with a polished surface; the form of the crystal is an octahedron: it is also found of a brown, green, rose-red, and blue colour. The diamonds of India are met with in the Ghauts mountains imbedded in gravel. They occur also in the island of Borneo, and in Brazil. Very recently some diamonds have been found at the foot of the Ural mountains in Russia, in the soil that contains gold-dust. Draw this pencil across the piece of window-glass on the table."

"It is cut quite through," said Frank: "now I know how the glazier made the pane of glass to the size of the window-frame."

"Let us turn to a mineral more extensively useful than the costly gem you have been admiring. You will scarcely know its appearance in this great mass. It is, you will find, soft, shining, sectile; and soils the fingers."

"It is *black-lead*," said Helen. "I know it by the dust I have scraped off: it is like that used to polish stoves and keep them from rust."

"Black-lead, or, properly speaking, *plumbago*, (for it is quite distinct from the metal, *lead*,) is composed of charcoal, with a small portion of iron. When exposed to an open fire, it burns without flame or smoke. The best plumbago is found at Borrowdale in Westmorland."

"Arthur is desirous to see the contents of that phial, which is full of *petroleum*. It is found in Colebrook Dale, Shropshire; and in many foreign countries. In some parts, petroleum is used instead of common oil for lamps. There is another mineral oil, called *naptha*, that is sometimes applied as a remedy for bruises. The Russians are said to take it as a cordial. Naptha is more fluid than petroleum."

"I thought this shining, black substance, had been pitch; but it looks different."

Asphaltum is a *mineral* pitch, so called from the lake in Judea where it is found. With this substance the bricks were cemented in building the far-famed city of Babylon. It occurs in Cornwall, and abounds in Trinidad, where there is a lake of asphaltum, three miles in circumference. In the West Indies it is applied to the bottoms of ships, to prevent the attacks of the ship-worm. Now try if my description corre-

sponds with the specimen in your hand, Arthur. *Asphaltum* is brittle: the fracture is somewhat conchoidal, and finely polished: it melts easily, and takes fire; but, when pure, does not soil the fingers. It is a good specimen: keep it.

"That well-known combustible mineral is the comfort of our lives in winter. We, who dwell in these northern climates, where damp or cold prevail for more than half the year, can scarcely be sufficiently thankful to the bounty of Providence, which has presented us with such unfailing supplies of fuel, in that great store-house, the earth. Useless would be costly furniture, and dwellings ornamented with marble and alabaster, when the cold of January bites the ground, or the dripping fogs of November chill our frame, if no cheerful blaze in the fire-place enlivened the room."

"I would rather see a fine fire than even tiree-marble round the chimney without it," said Helen. "Portland-stone will do for me: I do not care for costly things."

"Try if you can describe *common coal*," said Mr. C.

"I do not think it has any particular form."

"Yes it has, Helen," said Frank; "common coal is a cube: mamma made me see that."

"That is the general form: perhaps you will not agree with me when I say that it does *not* soil the fingers; which is, however, correct, for

the soil is owing to a mixture of charcoal with the mineral. It is black, shining, brittle, easily frangible, and of a thick slaty structure. The species you have taken up is *cannel-coal.* The conchoidal fracture is very evident: it flies into fragments, and burns with a bright flame. Some cannel-coal will bear polishing: it is made into various ornaments. You will scarcely distinguish it from *jet*, which lies beside it. The fracture of jet is also conchoidal: the colour velvet black. It will scratch amber, and is scratched by jasper. It becomes electric by friction."

"But this is only wood," said Arthur, taking up a piece of *Bovey coal:* "it is brown, and gives way easily to my knife."

"That species comes from the foot of Dartmoor: it is *Bovey* coal. *Staffordshire-moor* coal also is little else than the remains of wood: it produces wood-ashes if slowly burned. It divides into rhombic forms, blunted and variegated: in texture much like wood.

"This species will please you: it is *glance*, or *peacock coal.* There are several kinds: the best is called *anthracite.* It burns without sulphureous vapour. The metallic lustre is very fine."

"Here is a little tray full of brown dust," said Frank.

"It is *Cologne earth*, a variety of earthy brown coal. Large beds of it are met with near

Cologne in Germany, and likewise in Holland. It is used to adulterate snuff; and as a colour for painting, for which purpose it is kept by dealers in colours.

"There is a possibility that you may find some specimens of *amber*, for it occurs in gravel-beds near London. Try if sulphuric acid has any effect upon it. Sometimes amber is found with insects inclosed in it. When rubbed, it is strongly electrical."

"The acid does attack the amber," said Arthur; "and it may be scratched by a knife."

"Artificial amber may be made thus:—Tie up, in a fine muslin bag, the yolk of an egg, carefully freed from the white, and suspend it in a warm place. In about a month it will acquire the appearance and some of the qualities of amber; becoming hard, transparent, electric, and capable of receiving a fine polish."

"I will try that experiment," said Helen, "it is so easy."

"You are all acquainted with the common mineral with which my list of combustible substances will conclude; I mean *sulphur*. That specimen is native sulphur, from Spain. The other is volcanic sulphur, of a pale-green colour, from Italy. That roll of sulphur, or *brimstone*, is manufactured. The acid called *sulphuric* is procured from this mineral, which abounds in

the ores of metals, as in iron pyrites. With *iron*, sulphur forms *green* vitriol; with copper, *blue* vitriol; with zinc, *white* vitriol; and with cobalt, *red* vitriol.

"Now, Frank, hold this roll of sulphur in your hand for a minute."

"Oh, what a snap! The roll is broken. That is curious!"

"Sulphur easily melts," continued Mr. C. "to a brown, transparent fluid. If it is then poured into warm water, it becomes plastic, and will take very clear impressions of medals, coins, or seals. If sulphur is suffered to cool gradually, it crystallizes in fine, needle-like figures. It is best to heat it in an iron ladle. It takes fire readily, and burns with a blue flame."

"How small the class of combustible minerals is, compared with the earthy class," observed Arthur.

"There are a few other minerals belonging to it," replied Mr. C. "which I have not alluded to; for it is not my intention, as I have already noticed, to describe every species. The coal formation in this country must be interesting to all mineralogists who are desirous of knowing something more of a mineral than the mere outward appearance of it. The coal-field of the north-east of England extends over a great part of Northumberland and Durham. The chief

mines are situated on both sides of the river Tyne, not very far from its banks. Lancashire affords another coal-field: a third occurs in Derby and Nottinghamshire. Whitehaven coal-field extends along the coast, to St. Bee's Head; and a large formation occurs in Yorkshire. *Mill-stone grit*, *mountain* or *carboniferous lime-stone*, and *old red sand-stone*, are found accompanying the coal-measures, or fields."

"We do not know *mountain limestone*," said Helen. "I like the name of any formation that belongs to the hills."

"I shall show you the rock before we conclude: it is noted for fossil remains."

COMBUSTIBLE MINERALS.

Diamond.—The hardest of all mineral bodies; cuts all other minerals; burns entirely away.

Plumbago, (graphite or black-lead.)—Stains the fingers; leaves a black streak; sectile; soft.

Petroleum (rock-oil.)—Swims on water; inflames easily.

Naptha.—Perfectly fluid and shining; exhales a pleasant odour.

Asphaltum.—Black; brittle; melts easily; fracture conchoidal; does not soil when perfectly pure.

Common coal, (Newcastle coal.)—Brittle; frangible; shining black; structure slaty.

Cannel-coal.—Burns with a bright flame; flies into fragments; fracture conchoidal; takes a fine polish.

Jet.—Colour velvet black; fracture conchoidal; resembles cannel coal; burns with a greenish flame.

Bovey coal.—Dark brown; burns with an unpleasant odour.

Staffordshire-moor coal.—Divides into rhombic pieces; texture like wood.

Glance coal; peacock coal.—Shining and iridescent.

Cologne coal.—Variety of brown coal *(Cologne umber.)*

Amber.—Soluble in sulphuric acid only.

Sulphur.—Melts easily; burns with a suffocating odour; crystals in needles.

NOTE.—In the upper beds associated with Newcastle coal, portions of hard, black *basalt* are found. From this stone, the ancient Britons formed the heads of their battle-axes, called *celts*. Barbed arrow-heads of flint are often found on the moors, and are called *elf-bolts*.

CHAPTER IX.

CLASS III.—SALINE MINERALS.

Soluble in water; yield to the knife; taste sapid.

"We shall attend to the third class of minerals this morning," said Mr. C.: "can you recollect what they are called?"

"Saline minerals," said Arthur; "and then we shall begin the metals. I wish very much to know something of them."

"You will easily learn to recognize the minerals comprehended in the third class: it contains many substances that are in general use."

"We shall hear of common salt," said Frank; "but I do not see any common salt upon the table."

"What do you think of those fine cubes?"

"I think they are calcareous spar—no, fluor spar, which has its crystals in cubes.

"But what have we to do with *lime-earth* now?

You know that fluate of lime ranks among the earthy minerals.

"The characters of saline minerals are these: *soluble in water; taste sapid; yield to the knife.* This is the alkaline salt called *soda.* Its base is metallic, and is termed *sodium.* Soda with *muriatic* acid, is *muriate* of *soda,* or common salt. It cystallizes in cubes. There are large specimens on the table, Frank."

"But they are red and grey: that salt is not like our table-salt."

"The crystals are in their native state. Salt for household use is purified. Soda and *carbonic* acid form *natron.* It is found in lakes in Egypt. The water is evaporated by the heat of the sun, and the natron is left in crystallized masses. Soda with *sulphuric* acid forms *Glauber's salt,* which is very common in mineral waters. The crystals are six-sided prisms. It also occurs in a solid, crystallized form, in Persia and other countries. On exposure to heat, the water of the crystals fuses; and the salt swells or intumesces.

"*Borate* of soda, or *borax,* is formed of *sulphuric* acid and *soda,* and the *boracic* acid. Exposed to heat, it swells, boils, and becomes an opaque, porous mass. Native borax is called *tincal:* there is a specimen, yellow or greenish-white. The crystals have the power of double refraction. This salt, in a purified state, is used

in medicine. It is also very useful in fusing metallic ores, by the blow-pipe. It comes from the East Indies.

"*Epsom salt*, or *sulphate* of *magnesia*, is a valuable salt for medical use. The taste is cool and bitter. It crystallizes in four-sided prisms. Epsom mineral-water contains a considerable portion of this salt, whence it derives its name. It is also found native."

"I know the next salt, I think," said Arthur: "it is saltpetre."

"You are right; *saltpetre*, or *nitre*, is composed of nitric acid, and an alkali called *potash*, which has a metallic base like soda, and has received the name of *potasium*. In warm countries, particularly in the East Indies, Spain, and Naples, nitre is found on the ground in flakes and in capillary crystals. This salt *deflagrates*, or breaks out in flame, when laid on very hot iron, or on a red-hot coal: it may be known by this peculiarity. Nitre forms the principal part of gunpowder.

"*Muriate* of *ammonia*, or *sal ammoniac*, is found native in the lava of Etna and Vesuvius. That clear white mass is the salt artificially procured. Sal ammoniac, rubbed with quick lime, emits a pungent odour. Ammonia itself is a gas. The four next are metallic salts. *Green vitriol*, or *sulphate* of *iron* of an emerald green colour:

the crystals are rhomboidal. It is found in iron mines with pyrites, and is formed from the decomposition of this mineral. It is also pulverulent and pearly. The taste is metallic. Great quantities are manufactured. *Copperas*, as sulphate of iron is often called, nut-galls, gum-arabic, and water, form that useful liquid, *writing ink*. *Sulphate* of *copper*, blue vitriol, is another very common metallic salt."

"I have often seen these bright blue pieces in the colour-shops, and the green ones too; and lumps of yellow and orange earthy looking things," said Frank. "I am glad to know what they all are."

"We shall notice them in due time," replied Mr. C. "Blue vitriol is also manufactured, but it is found in native crystals. Dissolve some of it in water; dip the end of that steel bar into the water; now leave it, and light the wax candle. This white salt, like loaf-sugar, is *zinc* and sulphuric acid, *sulphate* of *zinc* or white vitriol. Before the flame of a candle it swells and bubbles. I shall leave you to discover if the other sulphates are influenced in the same manner."

"But is it found native?"

"Yes; both native and crystallized. The colour is often a greenish white. *Sulphate* of *cobalt*, *red vitriol*, is less common. The colour is pale red. Some mineralogists place these

metallic salts among the minerals of the class, metals. But they have entirely lost their metallic character, and from their solubility in water, more properly rank with the saline minerals, according to the opinion of others. Now look at the steel bar again."

"It is covered with copper! How can that be? Yet it is the same bar, I am sure."

"Consider a little. You dipped the bar into a solution of *sulphate* of *copper*. Now, sulphuric acid will leave copper to attach itself to iron: the steel bar, therefore, took up the acid; and the copper, in a metallic state, is left upon the surface of it. I have one more salt to notice: it is native *alum*, or *sulphate* of *alumina*. Small quantities only are produced naturally. It is manufactured from a black, slaty substance, called *shale*. It is soft to the knife. Beds of greyish black shale occur at Whitby in Yorkshire, of unknown thickness.

"I shall not give you specimens of these salts, as they are easily procured, and it will be more beneficial to collect them yourselves; always remembering that they are formed by art, and resemble the same minerals in their native state, or nearly so, in point of chemical properties. The methods by which they are artificially produced will be very interesting to you; but the process belongs more to chemistry than to mineralogy.

I can, however, spare you a specimen of native rock-salt; and you must recollect that salt is found with new red sand-stone."

"And gypsum too," said Arthur. "I remember seeing the specimen that had the two minerals in layers."

"At Northwich in Cheshire, the beds of rock-salt are upwards of three quarters of a mile wide. The salt of these mines is frequently of a reddish hue, arising from a mixture of iron. Whole mountains of salt occur in Africa. It abounds in Spain. The most extensive deposit of rock-salt is at the northern extremity of a branch of the Carpathian mountains, in Poland, not far from Cracow. I will read a description of the mine, when we meet at tea. Now point out to me the different salts, as I read the names from this list.*——

"Very well remembered," said Mr. C., when he had concluded; "and as our lesson has been somewhat short, I will show you the use of the blow-pipe."

"I am glad of that," said Arthur: "I have often heard or read about a blow-pipe."

"When a mineralogist wishes to examine a metallic ore, he generally has recourse to heat, and to his furnace, which will perform, in a small

* See the end of the chapter.

way, the same operation as the furnaces for smelting ores. This *pocket-furnace* is the *blow-pipe*. A piece of thick wax-candle, and his own breath instead of bellows, are all that is needed.

"The blow-pipe, you perceive, is a hollow tube of glass or metal, seven or eight inches long, tapering to a point, having the lower end bent to one side. The larger end being placed in the mouth, the air is blown through the pipe, against the flame of the candle: a degree of heat may be thus obtained, equal to that of a smith's forge. The tube is to be held in the *right* hand. In the left, a piece of charcoal, which serves as a support to the mineral that is to be examined, must be held near the *flame* of the candle, so that the pipe may convey it to the charcoal. If the mineral be a metallic ore, the fragment should not exceed the size of a pea: if an earthy one, the size of a pin's head is sufficient. A small cavity should be made in the charcoal, to lodge the piece of metal. These little forceps are often used for non-metallic minerals; but close-grained charcoal is the best support for those that contain metals."

"Your forceps are tipped with silver, I think, sir," said Arthur: "if the blow-pipe causes such a great heat, will not the points of the forceps be melted?"

"In a short time you will be able to determine

the nature of the substance yourself. But let us try our little furnace. Some dexterity is requisite in directing the current of air, that the flame may be driven upon the mineral, and a strong, regular heat maintained: the blue coloured flame is always the most powerful. To reduce the oxide of lead, or *red-lead*, as it is commonly called, is a very easy trial of skill."

"Can this red powder be turned into real lead?"

"You shall see. I place some of the red-lead upon the charcoal; and now I am going to force the flame of the candle upon it, by blowing through the tube."

"The charcoal is red-hot already," said one.

"I see little balls of lead!" exclaimed Helen.

"And there they are upon the plate," said Mr. C., throwing them off the charcoal. "Now we will reduce a metallic *ore*."

Mr. C. must know best, thought Helen, as he took up a piece of *sparry iron ore*, and broke off a fragment; yet it seems strange to take *pearl spar* and call it iron ore.

After subjecting the mineral to a red heat, it was placed on a plate, and Mr. C. gave Helen a magnet.

"Apply the magnet to the mineral in the plate," said he.

The particles clung instantly to it, to the surprise of the young people.

"I saw your look of incredulity, Helen," said Mr. C., smiling: "indeed, I believe you thought that I had made a great blunder. I give you credit for your humility and good sense, in waiting till the end of my operation. Pearl-spar, which you recollect is magnesian carbonate of lime, with a very small portion of *iron*, passes into *brown* spar, which is *spathose*, or *sparry iron ore*, or *carbonate* of *iron*, which contains sixty-six parts of iron, and only thirty-four of lime. When *brown spar* is heated, and the magnet applied, it is affected by it. This may always serve to distinguish it from pearl-spar."

"What a very nice experiment," said Arthur; "but the chief difficulty is making the mineral hot enough."

"The same result will take place if the iron ore is heated in the open fire; but you must be careful not to lose your little fragment.

"I shall leave you now, to practise blowing this useful pocket-furnace. Suppose you try its influence on lime, in the form of calcareous spar and gypsum. Some minerals are not fusible when exposed to the blow-pipe alone, which is the case with lime; but when *borax* is added to it, lime melts or *fuses*. A mineral that causes another to fuse when mixed with it, is called a *flux*. *Fluor-spar* is used as a flux for iron and

copper ores. Now tell me what you recollect about borax."

"Borax is a saline mineral. It comes from the East Indies. It is called *tincal* before it is purified."

Mr. C. left the room, and his young pupils soon found that the management of the blow-pipe requires dexterity. Arthur, always eager to effect his purpose, blew like Boreas himself, as Helen said. Frank plunged the end of the tube into the flame, or made it flare about. Steady Helen contrived, at last, to bring back a few globules of lead.

Arthur's account of their clumsy operations, as he called them, amused his mother and Mrs. C., who said that she foresaw the fragments of wax-candles would soon be put in requisition.

Mr. C. farther told him, that a clean tobacco-pipe, with the stem shortened for a handle, and the greater part of the bowl taken off, forms a good support for trying the colour that minerals give to borax.

"You must avoid taking too large a piece for your experiments," said he; "the fragment should not exceed the size of a pin's head, or a pea; and remember to reduce the borax to powder before it is placed in the half pipe. If a mineral decrepitates, as barytes will, it must be pulverized likewise."

SALINE MINERALS.

Soda.—Composed of sodium and oxygen.

Muriate of soda.—Common salt; crystallizes in cubes; colour red or grey; decrepitates with heat.

Carbonate of soda, (natron.)—Effervesces violently with acids.

Sulphate of soda, (Glauber's salt.)—Crystallizes in six-sided prisms; intumesces with heat.

Borate of soda, borax, (tincal.)—Crystals, three-sided pyramids; intumesces with heat.

Sulphate of magnesia, (Epsom salt.)—Crystals, four-sided prisms; taste cool and bitter; (*earthy salt.*)

Nitrate of potash, nitre, (saltpetre.)—Crystals capillary; colour greyish or yellow-white; distinguished by deflagrating on red-hot iron.

Muriate of ammonia, (sal ammoniac.)—Taste pungent; native colour grey, green, or yellow; crystals cubic; a volcanic production.

METALLIC SALTS, FOUR.

Sulphate of iron, (green vitriol or copperas.)—Found in iron mines; taste metallic; exposed to the air, falls into a white powder.

Sulphate of copper, (blue vitriol.)—Crystals eight-sided.

Sulphate of zinc.—Greenish white; dissolves in boiling water; intumesces with heat; (*white vitriol.*)

Sulphate of cobalt.—Colour, pale rose-red, (*red vitriol.*)

Sulphate of alumina, (native alum.)—Dissolves in water; colour white; opaque; soft; fuses and froths with a moderate heat; *(earthy salt.)*

CHAPTER X.

A VISIT.

"I SHALL not have time for a lesson to-day," said Mr. C., the next morning: "I am going to call on a gentleman who lives at some distance. I know the presence of young persons is no inconvenience to him, and I am sure the visit will afford you pleasure; therefore prepare for a long and very agreeable ride."

"Is the gentleman a botanist?"

"He is acquainted with every branch of natural history, and is particularly fond of mineralogy and geology."

"Then we may perhaps see some geological maps."

"Probably, if we are admitted into his library; but your patience and your good manners may be put to trial," continued Mr. C.; "for I am seldom disposed to give my friend the trouble of

showing his collection, if he does not propose it; because I am aware that he has many claims upon his time and his good-nature."

"Do you think the gentleman *will* be at leisure?" asked Frank.

"I cannot decide. Business obliges me to see him to-day; and he is not informed of my intentions."

"We shall have a good opportunity for looking about in search of flowers," said Helen; "for I know Mr. C. approves of our walking up the hills, to relieve the horse; and as we are going a long way, he will stop at some nice little inn, where the poor fellow may rest: and then we shall have a delightful ramble, as we had last week. We shall not fail to enjoy ourselves."

On their arrival at K——, the visiters were introduced into the parlour, by an elderly housekeeper, who brought them refreshments, and begged Mr. C. to stay till her master's return.

Meantime, the chimney-piece of the apartment attracted Frank's notice; for he had become indefatigable in his study of *marble*.

"That is Derbyshire, or *encrinal marble*,"* said Mr. C.: "*compact lime-stone*, not granular marble."

Two beautiful slabs of *malachite* were on the

* See plate 1, figure 4.

mantel-piece, fine green cubic spar, and some masses, which the young people thought were full of stony-looking screws or pullies. The spar was soon recognized, and the green slabs they supposed were marble, that Mr. C. had not described.

"But these screws," said Arthur, "what are they made of? The earth they are fixed in looks like coarse limestone."

Helen took out her magnifier, and discovered that the screws were formed of *calcareous spar.*

"We must know what ground you have for your assertion, my dear, before we can admit the probability of its correctness."

"I see the rhombic forms," said Helen, "and they give way even to a pin's point: oh, if I had but a little acid!"

"You are right, Helen, the screw stones are animal remains, converted into calcareous spar. The whole is a mass of *mountain limestone.*"

"Perhaps the young lady would like to see the old sideboard, sir," said the housekeeper, who had remained to wait on the visiters.

"There is no doubt of that, Mrs. Mays, if you will take the trouble to show it to us," replied Mr. C.

"Master calls this the *Petworth room,*" said she, opening a door.—The chimney-piece, hearth, and all the slabs, were of Petworth marble, or

Sussex marble, as it is sometimes called. These compounds of clay and lime contain shells of the *vivipara fluviorum** kind: the interior of them is filled with calcareous spar. When the mass is hard enough to admit of a polish, it receives the name of *Petworth* marble. A finer variety, used for lighter columns, is termed *Purbeck* marble.—"The sideboard is so old," continued Mrs. Mays, "that the shells may be easily taken out. The room is damp, and seldom used: it is the oldest in the house, which I believe is also very ancient. Most of the large old houses in this county† have Petworth marble for some purposes; but I have heard that it is not much used now. If you young gentry should ever go into Canterbury cathedral, be sure to ask for the archbishop's chair, which is formed of this marble."

"Where can we see Petworth marble?" asked Frank; "near London?"

"In most old churches and cathedrals," replied Mr. C., "as in Westminster Abbey. The Temple church, and St. Helen's, not far from Cornhill, will afford you examples of tombs. The colours are usually bluish grey, mottled with green and yellow. *Purbeck* marble is like it, but the shells are smaller."

* Now paludina. † Sussex.

Shortly after their return to the parlour, to examine the green slabs, the owner of the house arrived, and gave them a friendly welcome.

"You were looking at my chimney ornaments," said he, "do you know the nature of them?"

"I believe the centre piece is fluor," replied Arthur, "but the others we never saw before. Helen thinks those screws are lime: she has tried with a pin, and the crystals give way."

"So," said the gentleman, "you are something of mineralogists, I perceive."

"Thanks to our kind friend," said Arthur, "we have learned to distinguish a great many minerals since we came to visit D——."

"And how far have you proceeded, young lady?" continued the gentleman, addressing himself to Helen.

"We know three classes, sir, and we hope to begin the metals to-morrow."

"My friend was right to leave them for the latter part of his instructions, you will understand them better. Does this little fellow know any thing about the matter?"

Frank was afraid of boasting, and looked at Mr. C., who answered, "He listens attentively to my instructions, and is a diligent collector of stones and marbles."

"Can these young folks be trusted?"

"Entirely."

"Then," said the gentleman, opening a door that communicated with his study, "go and amuse yourselves in that room, but do not take any thing up from its place."

"*No, sir,*" said all three together.

It was a delightful room to young students; filled with cases of minerals, shells, and fossils, together with corals, and large fragments of various rocks. A catalogue lay open, the numbers of which corresponded with those on the specimens.

They saw arragonite in its most beautiful forms; calcareous spar of various kinds; alabaster, both calcareous and gypseous; polished marbles, and limestones; quartz in splendid crystals; chalcedony, barytes in beautiful forms, clay-slates, granites, and porphyry. The brilliant collection of metallic minerals increased their desire to become acquainted with them; and they learned, with surprise, that the beautiful green marble, as they believed it to be, is in fact a carbonate of *copper*, and belongs to the metallic class.

They were so much occupied, that some time passed before a very large map attracted attention. From the form, they knew it was a map

of England and Wales: the words, *oölite*, *red sand-stone*, *chalk*, &c. convinced them that they saw a geological map.

"I know granite and serpentine," said one; "and I know red sand-stone and clay-slate."

"There is Hastings on the iron sand," said Helen; "Dover on the chalk, and Folkstone on the green sand, and London on the blue clay."

"Only look at the coal measures, Arthur, that Mr. C. was telling us about, and mountain lime-stone in Derbyshire. I will ask mamma to buy one of these maps."

The shells were just receiving their share of admiration, when Mr. C. summoned his young companions. The gentleman enquired if they had noticed his collection of fossils, and would have persuaded Mr. C. to take an early dinner, that he might have the gratification, as he obligingly called it, of introducing these curious objects to their notice and future study. But a promise had been given to return before night; and the gentleman desiring a few minutes' delay, quickly presented a small parcel to each of the young folks.

"I hope," said he, "that the treasures of the South Downs will, in due time, afford you all a great portion of amusement and information. Those are specimens of English fossils, which I think will please you."

Many thanks were offered for this unexpected kindness; and many times the children turned to look at their new friend, who watched them out of sight.

"Those children have the best manners of any who have come to this house for a long time," said the gentleman to good Mrs. Mays, who always appeared in the hall, when her master's young guests were about to depart, that she might see them properly attended. "They are humble, and need a little encouragement; and that intelligent girl will be charming, if she grows up with those manners. Did you hear how gratefully she expressed herself as she took leave? They shall come and spend a day or two, if their mother will permit, and my niece can go over and fetch them."

"I can scarcely express how much gratitude we owe to you, sir," said Arthur, as they rode home. "Two months since, and the nature of those objects in your friend's delightful room would have been quite unknown to us; we should soon have grown tired of them: now, we found ourselves with old acquaintances. It is true, we perceived how much we have to learn; but we

could understand that the fine varieties we saw were all allied to the more common calcareous and siliceous species, with which you had made us acquainted."

"I can hardly believe," said Helen, "that the red-looking metal, copper, does really change into any form so beautiful as malachite, and the green branch that was named *dendritic copper*."

"I wonder whether Mr. C. has any such copper," said Frank.

"Yes, and arborescent gold and silver, for your consolation."

"And will you be so kind as to tell me something about my fossils?"

"Certainly; but I prefer to conclude our introduction to mineralogy first. Let us see, however, what my friend has given you. Some *entrochites* and some *Cuthbert's beads*. Now, Helen, what is yours? a *cidaris*, or *echinite*, and a slab of chalk with spines imbedded; and Arthur has a fossil oyster. Here is another, with Helen's name written upon the paper. A string of *fossil teeth*, that were once in use as ornaments, and a *belemnite*, for Arthur."

"Do these fossils come from the South Downs?"

"The echinite and the belemnite are marked to that effect; but we have reached our own gate, and there are the ladies coming to meet us."

CHAPTER XI.

CLASS IV.—METALLIC MINERALS.

MALLEABLE METALS, AND THEIR ORES.

Mineral bodies that possess a metallic lustre when scraped, and in specific gravity exceed 5, are metallic.*

"I HAVE been selecting specimens of the metallic minerals," said Mr. C., as his pupils entered the study the next morning. "The British Museum will afford you a rich variety of rare and valuable ores: I think you will find that collection exceedingly interesting. I shall show you the more common ores, which you will most probably often meet with."

"Shall we have occasion to observe the crystals?"

"Certainly, the crystallization of metallic minerals is often very beautiful. We shall also need the acids, the knife, and the blow-pipe. Mineral bodies, especially metals, vary with respect to their weight. The greater part of the earthy minerals are *less* than three times their

* Three of the brittle metals do not however reach 5.

weight of water. This is called their *specific gravity.*"

"Is the weight of any substance compared with the weight of water?"

"By common consent, distilled water is made the standard of comparison. Suppose we find that a cubic foot of water will weigh *one* thousand ounces, and a cubic foot of iron *seven* thousand ounces; then *equal bulks* of iron and water being weighed, the iron is found to be seven times heavier than the water. I will write down the specific gravity of silver, thus: 10.50,* which signifies, that silver is ten and a half times heavier than water. In the following lists of the malleable and brittle metals, the specific gravity of each is noted down for you. I have already observed, that *most* of the earthy minerals do not exceed 3, that is, when any of those minerals and water are weighed, the *greater* part of them are not more than three times heavier than the water. I refer you to the "Scientific Dialogues" of Joyce, for farther information on the subject of specific gravity. Now read the names of the twenty-seven metals."

TWELVE MALLEABLE METALS.

	Times heavier than water.
Platina . . .	23.
Gold . . .	19.36

* Or 10.5: this number is a decimal part.

	Times heavier than w
Mercury	13.6
Lead	11.35
Palladium	11.8
Silver	10.50
Copper	8.80
Cadmium	8.6
Nickel	8.4
Iron	7.70
Tin	7.29
Zinc	7.

SEVENTEEN BRITTLE METALS.

Osmium	19.
Iridium	19.
Rhodium	11.
Tungsten	17.
Bismuth	9.82
Uranium	8.10
Cobalt	8.
Arsenic	8.31
Molybdena	7.
Tellurium	6.11
Antimony	6.70
Manganese	6.
Columbium	5.90
Chromium	5.90
Cerium	4.98
Titanium	4.42
Selenium	4.3

"What a number of metals that I never heard of before!" said Arthur. "But is arsenic really a metal? I thought it had only been a white powder. I have heard of antimony as a medicine also, but I had no idea that *metals* are used in curing diseases."

"Mercury, lead, iron, tin, and zinc, are all to be found on the list of remedies for either internal or external disorders of the human frame.

Platina is the *heaviest* of all metals: the specific gravity, you perceive, is twenty-three times heavier than water, when the metal is quite free from alloy. The name is derived from the Spanish word *plata*, silver, which it resembles in its colour. It is found in grains, and in pieces not larger than a pea, in Brazil, Peru, Mexico, and in Russia. Platina is extremely difficult to fuse or melt, and, like iron, is capable of being welded, or made to adhere by hammering in a very strong heat."

"Now I know what the tips of the forceps are formed of," said Helen: "they must bear a great heat, and therefore the metal is used that fuses with difficulty."

"You are right, Helen. Platina spoons and cups are also to be obtained for chemical experiments. It is used for pendulums, watch wheels, and speculums for telescopes. It is soluble in nitro-muriatic acid, or *aqua regia*, as it is some-

times called. *Palladium* is found with platina: it is very rare. *Native gold* is found crystallized in cubes, octahedrons, and many other forms. This foliated specimen is very beautiful. It is found disseminated in quartz; and that mass is gold, accompanied by felspar and carbonate of lime. The metal is very malleable: one grain of gold may be made to cover about fifty-seven square inches. It is soluble in aqua regia, but remains unaltered in the hottest furnace. Put a little of this leaf-gold into the watch-glass, with a few drops of muriatic acid: now add nitric acid."

"The gold is dissolved," said Arthur: "then that must be aqua regia, or nitro-muriatic acid."

"Gold-dust is often adulterated with pyrites, which the purchasers know not how to detect. Some of the better-informed negroes make a trade of trying gold; and when thus employed, they are treated with particular attention by the merchants and captains of ships, who admit the negroes to their tables, finding that they are saved from great imposition by their skill as *tryers.**

"Is shell-gold the real metal?" asked Helen.

"*Shell-gold* should be gold-leaf ground with gum-water or with honey boiled fine; but shell-gold is often adulterated."

* Mawe.

"How can we detect it?"

"Here is a *mya*, or *unio pictōrum*, with gold in it. Take out a small quantity, and drop nitric acid into the watch-glass, when you have put in the gold. If it is mixed with brass, the colour will be green."

"There *is* brass in it!" exclaimed Frank: "now we have found out the cheat like the negroes. It is a good thing to have knowledge, for even the poor negro is of some consequence to the merchant then. Is gold found in England?"

"Yes, and in Scotland and Ireland. It is the softest of any metal except lead, and requires an alloy to harden it for most uses. Gold coin is alloyed with copper. Gold may be distinguished from native *copper*, by the greater hardness of the latter metal; and from copper pyrītes, by being malleable."

"Oh, look at that silver running about!" said Frank, as Mr. C. placed a tray with *mercury* on the table.

"That is *quicksilver*, or *mercury*," replied Mr. C.: "a most useful metal. It assists us to ascertain the warmth or coldness of the air we breathe, to foresee the changes of the weather, and to measure the heights of mountains."

"I know what you allude to," said Helen. "The tubes of thermometers and barometers are filled with mercury, which is influenced by the

state of the air. But it ranks with malleable metals; how can this fluid be hammered?"

"Mercury is fluid in the common temperature of the air: this distinguishes it from all other metals. Cold renders it solid: it will then bear extension under the hammer without breaking. This is *cinnabar*, or *sulphuret of mercury:* it is scarlet, and sometimes steel-grey. The metal itself is soluble in nitric acid: take a globule and prove it. Mercury completely dissolves gold, silver, lead, tin, bismuth, and zinc. Glass is *silvered* with a mixture or *amalgam* of tin and mercury. Combined with muriatic acid, it forms the poisonous *corrosive sublimate. Calomel* is a mercurial medicine. The quicksilver mines of Idria in Saxony, of Spain, and Peru, are very rich: they are commonly situated either in calcareous rocks or indurated clay."

"How very fine these green-looking minerals are!" said Helen. "I see *lead* is next on our list, but it is very different in colour to these specimens, which are a fine grass-green."

"You are acquainted with the metal in the metallic state only," replied Mr. C. "Those are *phosphates of lead:* try a fragment in nitric acid, it will dissolve. *Lead* is never found native, or in the state of a metal: the ores are numerous. This is *galena*, the most common ore of lead: it is found in immense quantities

in beds, and in veins in argillaceous rocks; in limestone, accompanied by quartz, barytes, carbonate of lime, and fluor spar. The specimen before you is crystallized in cubes, which is the primitive form. Now observe the characters of galena: it yields to the knife, is sectile, breaks with ease; it is not *perfectly* soluble in nitric acid. The ores of lead are reducible to the metallic state before the blow-pipe. Galena is lead with sulphur: we shall drive off the sulphur, and the lead will remain in a globule on the charcoal."

The experiment succeeded, and Helen observed that galena differed from black-lead or plumbago in its lighter colour, greater weight, and that the streak it made was much fainter.

"Here is a pretty specimen of quartz on galena; the other mass I wish you to examine, Arthur, and let us know of what it is composed," said Mr. C.

"I think," said Arthur, "that I see *galena—calcareous* spar, for it yields to the knife, and effervesces—*quartz*, and some clear, white *fluor spar*, for it gives way to the knife, is scratched by quartz, and does *not* effervesce. Am I right?"

"Entirely: I give you the specimen."

"How pleasant it is to tell the different kinds of minerals in the same mass!" said Frank; "and I do think that I have seen those yellow

and orange-coloured pieces in the shop windows."

"They were bought for the purpose of making you acquainted with *chrome yellow*, a preparation of lead. I am not worth a natural specimen of the *chromate*. These flakes of deep yellow and red are an oxide of lead, called *litharge*. This is manufactured, as well as red lead or *minium*. Both litharge and minium are easily reduced to the metallic state on charcoal, by the blow-pipe. Lead melted in the open air, attracts the oxygen or pure air, which forms part of the atmosphere we breathe: it is then called an *oxide*. The rust of iron is an oxide.

"I have heard of *white lead*," said Helen, "may we know what it is?"

"White lead, or *ceruse*, is the metal dissolved in vinegar. Ceruse affords a sweet crystallized substance, called *sugar of lead*, a deadly poison, in very common use for several purposes. Litharge, boiled in vinegar, is *Goulard's lotion*: it also becomes thick in oil, and forms part of many paints and healing plasters. Litharge fused with common salt, decomposes it, by attracting the muriatic acid. You may try this experiment: a yellow substance ought to be the result of it."

"Can silver be lighter than mercury?" said

Arthur, as some of the metal was placed before him; "yet I see by the list that it is."

"The ores of *silver* are more numerous than those of gold," said Mr. C.: "it is found native. That specimen of *arborescent* silver is beautiful. The most productive mines of this metal are in Peru and Mexico; but it occurs with other metals very frequently. The ores of lead, arsenic, and antimony, often contain silver. The *muriate*, called *horn silver*, or *kerate*, may be known from other metallic minerals by well-marked characters. Observe, it yields to the knife, and even to the nail, and is fusible in the flame of a candle; the colour is pearl-grey. Breathe upon it, and then rub it upon this piece of zinc; the surface is covered with a film of silver. Nitric acid diluted, is the proper solvent of silver. If the solution remains green, the silver has been tarnished with copper. Nitrate of silver stains the skin brown—hair, silk, and linen, nearly black."

"Is not marking-ink some preparation of silver?"

"Usually the nitrate, with water and a little gum. Silver is *recovered* from its solution thus: put a little of the nitrate into the watch-glass, and drop in this particle of copper, you will see a fringe of silver forming all round it; the copper has more affinity for the acid, which leaves

the silver to attach itself to the other metal. Silver has a strong attraction for muriatic acid. Dissolve a little common salt in water, and drop in the most minute quantity of the nitrate of silver, and the water will become milky: the silver leaves the nitric to unite itself with the muriatic acid."

"But where is the muriatic acid?" asked Arthur.

"Can you answer your brother's question, Helen?" said Mr. C.

"Common salt is soda and muriatic acid," replied Helen: "the metal joins the acid of the salt, I believe."

"I ought to have remembered that," said Arthur; "but is our lesson finished?"

"Yes, and I recommend you to examine all the metallic ores well, before you proceed, and to refresh your memory by looking over the earthy minerals. This is a list of the six malleable metals, that I have been noticing to-day."

MALLEABLE METALS, AND THEIR ORES.

1. *Platina.*—Is found native, or in a metallic state; dissolves in nitro-muriatic acid.

2. *Gold.*—Native; dissolves in nitro-muriatic acid; distinguished from *copper* pyrites by being insoluble in nitric acid, and from *iron* pyrites by its malleability.

3. *Mercury.*—Native; fluid; volatalized by heat; soluble in nitric acid.

Cinnabar, (sulphuret of mercury.)—Colour scarlet, or steel grey.

4. *Lead.*—Is not found native; soft, yields to the knife.

Phosphate of lead.—Colour green; soluble in nitric acid.

Sulphuret of lead, (galena.)—Distinguished from *blende*, the ore of *zinc*, by retaining its lustre when scratched.

5. *Palladium.*—Very rare; found with platina.

6. *Silver.*—Native; in leaves and filaments; soluble in nitric acid.

Muriate of silver, (horn-silver.)—Fusible in the flame of a candle; soft, yields to the nail.

CHAPTER XII.

METALLIC MINERALS CONTINUED.

MALLEABLE METALS, AND THEIR ORES.

"I THINK we are to hear something of iron to-day," said Arthur, "for here are iron pyrites on the table, with several other ores. Mr. C. is coming immediately: he says that he shall conclude his instructions in two more lessons. But he has promised to give us a little information concerning fossils: we may perhaps meet with some, and I like fossils almost as much as I do minerals, though it is true we have not seen a great many yet. They seem to be connected with minerals too, I think."

"Well," said Mr. C., as he joined his pupils, "have you determined the point that we debated at breakfast—which metal is more valuable in itself, according to your opinion, gold, or iron?"

"*Iron*, I think," replied Helen. "I believe I understand now that gold is taken in exchange

for labour, or for articles of use or luxury: it is only the *representative* of wealth. But iron is in itself useful: it can be formed into tools and implements for tilling the earth, and for various domestic purposes. *Gold* can only purchase them."

"Then," said Frank, "a bag of fowl cowries would buy Indian corn in some parts of the world, where shells are used for money, while a bright guinea would not be so valuable."

"And at Sparta," observed Arthur, "a piece of iron would have bought a lance, but the same weight of gold would have been rejected."

"But in England and Sparta, and the countries of Africa, an iron instrument to till the ground would be positively useful; so that iron is *really*, gold only *nominally*, valuable."

"My land and my farming-stock would be real wealth," said Arthur: "there is another reason for being a farmer."

"And your knowledge, Arthur, is real wealth. If mineralogy, for instance, prevents you from spending your time or your money in useless projects, like the proprietor of the Malvern mine, the knowledge you gain of the science will be really valuable. Quantities of shining dust have been sent over from South America at a heavy expense, which proved to be only gold-coloured mica."

"If Helen had been there," said Frank, "she could have done a great deal of good, for she knows the difference between mica and gold, and she likes to do good."

"I hope that Helen and Arthur, and Frank too, will be able to do good with the knowledge they gain during their lives. We owe much to our fellow-men. It is through their accurate observations, and industrious perseverance, that we acquire much information in a short time: we should endeavour to repay the benefit, by teaching those who know less than ourselves, when proper opportunity offers.

"The useful and plentiful metal, *copper*, is the next in order on our list: it is found native. There is a specimen of *arborescent* copper; the cubic form of the crystals is easily perceived: the ores of this metal are numerous. *Red copper ore* is before you, containing, at once, native copper and its oxide in eight-sided crystals. It gives way to the knife, and fuses before the blow-pipe."

"How very soft it must be! I always think of metals as very hard substances, yet many earthy minerals are harder."

"Lead is remarkably soft: you must recollect how easily it is rolled; it may be written upon. How readily copper yields to the tool of the engraver; how many beautiful scenes,

and revered or admired countenances we behold, through the cheap and beautiful art of engraving on copper! I believe you have seen a large specimen of this *green carbonate of copper.*"

"The green slabs that we saw at K—— Hall were exactly like it. Can this be copper? How metallic minerals change their forms, by being combined with the acids! There are the waving lines so beautifully green; and it effervesces in nitric acid."

"There is a pretty specimen of the *blue carbonate,*" said Mr. C.: "the bright blue of these four-sided pyramids is very striking. The earthy varieties of these minerals are *mountain blue* and *mountain green. Variegated,* or *peacock ore,* is remarkable for the brilliant colours that occur in it—as gold, blue, green, purple. It is a *sulphuret* of copper. The next will remind you of iron pyrites; but one character of *copper pyrites* is that of yielding to the knife, while iron pyrites resist both the file and the knife. Copper pyrites are crystallized in tetrahedrons, or figures of four sides; they are scratched by iron pyrites; they do not strike fire with steel; and are soluble in nitric acid. The greater part of the copper of commerce is obtained from this ore. It occurs in most rocks. Small crystals are frequently to be seen sprinkled on other minerals."

Mr. C. then produced some sheets of metallic foil, which Frank knew to be similar to the gold-leaf so frequently used in gilding cakes.

"Now," said Mr. C., "put some of this falsely called leaf-gold into the glass with nitric acid, which you see dissolves it."

"What a pretty experiment!" said Helen: "the leaf is consumed in an instant, and the colour is green: there is copper in it."

"It is called *Dutch metal*, and is, in fact, *brass leaf*, being a mixture of copper and zinc, a most injurious compound. I hope, Frank, *you* will try to prevent your little friends from eating gilded cakes, now you know that they would eat poison. Copper and zinc form brass, pinchbeck, and tinsel: a little nitric acid will easily prove to you that all is not *gold* that glitters. Copper is very sonorous: it is drawn out into strings for musical instruments. In mills for the manufacture of gunpowder, all the tools, nails, and hoops, are made of copper: can you tell the reason of this?"

"Copper does not give fire with steel, like iron, and a single spark will do terrible mischief in those powder-mills."

"I suppose that Frank is acquainted with this dark green substance?" said Mr. C.

"Yes," replied he, "they have it in the colour shops, pray tell me what it is called."

"*Mineral green*, a preparation from copper. Dissolve a little in nitric acid, and dip in the steel rod: if there is copper, you know the result."

"It will be seen coating the steel rod," said Arthur.

"Verdigris is also prepared from the same metal; and the green rust that is sometimes seen on copper, is the surface of the metal completely oxidized: when partially oxidized, the copper is of a deep red-brown. The oxide of copper is used in colouring glass and porcelain *green*. The great depository of copper ore is Cornwall."

"Now we are to see some ores of iron," said Arthur. "I know that metal is not poisonous, for it is used in medicine."

"The use of a mineral in medicine is no *positive* proof, Arthur, as you will learn, perhaps.

"Iron is the most universally diffused of all metals. Sands, clay, plants, water, even rain and snow, are scarcely ever free from it. The ores are numerous. *Magnetic iron ore* is the loadstone: there it is, with a heavy nail fast clinging to it. *Specular iron ore* has shining, smooth, and variegated crystals: it is abundant in the isle of Elba, whence this specimen comes. *Iron mica* occurs in black, shining scales, which appear red when held to the light. With the

sulphuret of iron, or iron pyrites, you are already acquainted. The ore is found abundantly. The cubic form is a common one. Iron pyrites may be known from copper pyrites by striking fire with steel, and not yielding to the knife. Kept in a red heat, the particles become magnetic, which is common to the ores of iron. In Cornwall this ore is called *mundic:* it is the only mineral substance common to chalk. *Quartz* is very usually found with iron pyrites. It occurs sometimes in large masses, in a globular form, which are called *brass lumps:* when broken, the interior is radiated. Occasionally the form is cylindrical, and bears the old name of *thunder-bolts*. The substance of fossil-shells, particularly *cornu-ammonis*, is often composed of this ore. With the *carbonate of iron*, *spathose*, or *sparry* iron ore, you are already acquainted, and know the distinction between it and pearl-spar."

"Yes," said Arthur; "spathose-iron is magnetic; but pearl-spar is not. The colour of the iron ore is brown and yellowish."

"Clay iron-stone, or *lenticular iron ore*, looks like little brown mallow-reeds, laid thickly over each other. The colour is grey or brown. It is found among the coal deposites. *Brown hematites* is found in a stalactitic form, of a brownish-black colour: sometimes it is like coral in form.

Bog iron ore is yellow-brown, soft, and earthy. It is found in swamps, and at the bottom of stagnant pools. This *azure iron ore* is common in gravelly or clay soils. We are told by Sowerby, in his Mineralogy, that it is found a little way beneath the surface of the ground, partly attached to pebbles, or the hollows they have made."

"Then we may have a chance of finding this blue ore, for there is plenty of gravel round London."

"The next three species, you will scarcely believe, are varieties of *iron ore*. They are very easily procured; therefore do not fail to purchase, and make yourselves well acquainted with them. These brown pieces, with a conchoidal fracture, having loose, yellow grains of ochre scattered over their surface, are an oxide of iron, generally called *terra Siennæ*, or *Sienna earth*, having been first brought from Italy. It has been found in our own country. *Umber* is dark brown, a variety of iron ore, called *brown stone ochre*. It is soft, adheres strongly to the tongue, and falls to pieces in water. It received its name from Umbria, near Spoleto, in Italy, where it was first found. *English ochre* is a variety of brown iron ore. It is found in pits at Shotover-hill, Oxfordshire. It is soft; stains the fingers; the fracture is earthy, showing a dull and rather

rough surface, like chalk. *Reddle* bears as little resemblance to iron, as the ochres we have just noticed. It is, however, a variety of red iron ore. It is soft and meagre to the touch, stains the fingers, writes easily, leaves a red streak, adheres to the tongue. What mineral does it remind you of?"

"Red bole," replied Helen; "but this reddle stains the finger even more than bole."

"I will only farther mention *meteoric iron*, which is formed in masses in the air, and falls to the earth. A large specimen of this iron is to be seen on the stair-case of the British Museum. *Steel*, is iron refined: it receives a dark-blue colour on being exposed to heat.

"We must now turn our attention to the metal called *tin*, of which Cornwall and the west of Devonshire afford the greater portion. It is not very widely diffused, but occurs in other parts of the world. In the early ages, the county of Cornwall was covered with woods, which were employed to reduce the metal. Coal is now used for the purpose. The business of smelting the ore was formerly in the hands of the Jews. The veins of tin generally pass through granite and clay-slate."

"Is tin ever found pure, like gold?"

"Tin does not occur native. Before you is a mass of *granulated tin*, which will give you an

idea of the metal. This is the tin of commerce. The metal, when fused in large quantities, cools in long angular prisms, like those you see. Tin is very soft, easily fusible: this distinguishes it from silver. *Oxide of tin*, or *tin stone*, is a common ore: it is a blackish brown, gives sparks with steel, and decrepitates before the blow-pipe. Those little, black, shining crystals are the tin: they are of various forms. A scarce ore of tin is sometimes found, called *wood-tin*. Here are some specimens. The colour is hair-brown. It resembles a piece of wood, cut from a knotted tree. It has a fibrous structure. Tin is soluble in nitric and muriatic acid: it unites easily with other metals. It forms the principal part of the compound called *pewter*. It is extensively useful in covering the surface of iron and copper. Tin is sonorous; hence its use in the formation of organ-pipes.

"Now, Frank, we will perform the operation of *tinning copper*. Do you make that copper coin perfectly bright and clean, either by scraping or rubbing it. That little charcoal furnace was brought up just now, that we may perform the experiment in two ways."

"Pray tell me what that liquid is," said Arthur, "that looks like water."

"A solution of sal ammoniac, with which I am going to wash the piece of copper. I now pour

the melted tin over, and the tin will cover the surface."

"What a very pretty experiment! But what is that little vessel for?"

"To boil another clean piece of copper, wrapped in tin-leaf, or foil. I suppose you know these silver-looking sheets, Frank, usually called *white metal.* In the little boiler is a solution of alum. Now put in the metal: the water is hot. In a short time the surface will be *tinned.* A piece of tin-leaf, laid on a copper coin that has been washed with sal ammoniac, will cover it, if you place the copper on the bar of the stove, and let it get gradually hot. This is yet more easy than melting the tin."

"Where can we procure this granulated tin?"

"The pin-makers frequently place it in the shop-windows for sale: you need only ask for it. I will give each of you a piece of wood-tin: you must purchase the metal. It is for your benefit to go in search of these things yourselves. In asking for one mineral, you will frequently gain information, and even the sight of several: at least, you may learn some of its useful qualities, or hear whence it was brought. I know your good mother approves of your giving attention to all subjects that are likely to make you wiser or better.

"With *zinc* I shall close the present lesson. It is also the last of the malleable metals on our list. The two common ores of zinc are *calamine* or *carbonate of zinc*, and *blende* or *sulphuret of zinc:* this is called *black jack* by the miners. Calamine is usually grey or yellowish. Try with a knife if that mass will yield. Very easily, you see. It effervesces in muriatic acid, and dissolves. It is infusible by itself."

"How very much like lime-stone it is," said Arthur; "but it weighs heavier, I think."

"Twice as heavy," replied Mr. C. "Black blende is a bright-looking mineral: its crystals are tetrahedons, having three sides and a base. The varieties are brown and yellow. When blende is scraped it does not preserve its lustre like galena, nor when breathed upon does it recover its brilliancy immediately. The fracture of the *metal* is starry: it melts easily, with a yellow-green flame, and rises in white smoke, or *volatilizes*. Bring a piece of brass-leaf, or Dutch metal. What is it?"

"Copper and zinc. We dropped nitric acid upon it, to dissolve the copper," said Arthur; "and it seemed to inflame. I saw smoke."

"Zinc has so strong an affinity for oxygen, that it inflames as soon as it comes in contact with it. The oxygen is in the nitric acid, which is composed of nitrogen and oxygen.

"Zinc, in fine filings mixed with gunpowder, produces the brilliant stars in fire-works. It is used by the braziers in soldering. It is called *spelter*.

"The three sulphates, namely, green, blue, and white vitriol, are referred, you will remember, to the class of *saline minerals*."

"Could the metal be regained from a metallic salt?" asked Helen.

"If sulphate of copper, or blue vitriol, is dissolved in water in a phial, and tin-leaf or foil added, copper will fall to the bottom. The phial must be kept for some days in a moderate heat.

"Iron filings, dissolved in diluted sulphuric acid, and the liquid evaporated, will produce the salt *sulphate of iron*, or green vitriol. I recommend you to be very careful in using these strong acids: always place the phial on a plate while you are employing them. Here are the names of the four metals and their ores."

MALLEABLE METALS, AND THEIR ORES.

1. *Copper.*—Native; sectile; flexible; sonorous; soluble in nitric acid.

Red oxide of copper.—Yields to the knife; easily reduced on charcoal by the blow-pipe.

Green carbonate of copper (malachite.)—Lustre silky; effervesces in nitric acid; is scratched by the knife. (Variety, *mountain-green;* earthy.)

Blue carbonate of copper.—Crystallized in four-sided pyramids; deep blue. (Variety, *mountain-blue;* earthy.)

Sulphuret of copper; peacock ore.—Soft to the knife; melts easily; blue, green, purple.

Copper pyrites, (sulphuret of copper.)—Softer than iron pyrites; yield to the knife; do not give sparks with steel; resemble gold, but are not malleable.

2. *Iron.*—Native; very rare; dissolves in diluted sulphuric acid.

Oxide of iron, magnetic iron ore, (loadstone.)—Fracture conchoidal; yields to the knife; brittle.

Specular iron ore, (crystalline iron glance.)—Crystals rhomboidal, coloured.

Sulphuret of iron, (iron pyrites, mundic.)—Strike fire with steel; do not yield to the knife; scratch copper pyrites; crystals in cubes; often forms the substance of fossil shells.

Clay iron-stone, (lenticular iron ore.)—Yellow-brown, in masses; yields to the knife; breaks easily.

Brown hematite.—Brown, tuberous, stalactitic, or radiated; yields to the knife.

Bog iron ore.—Yellow-brown; soft and earthy.

Azure iron ore.—Blue; earthy; found in beds of clay.

Terra siennæ.—Variety of brown iron ore; earthy; fracture conchoidal.

Umber, brown stone ochre.—Variety of brown iron ore; earthy; dull; fracture conchoidal; adheres strongly to the tongue.

English ochre.—Variety of iron ore; surface glossy when cut or rubbed with the nail; fracture somewhat conchoidal; colour yellow.

Reddle, or red chalk.—Brick red; stains the fingers; writes easily; (variety of red iron-stone.)

Meteoric iron.—In large masses; exterior rusty brown; streak shining; fracture delicately foliated.

3. *Tin.*—Soft; fusible; the lightest of the malleable metals.

Oxide of tin, (tin-stone.)—Very heavy; gives sparks with steel; reduced to metal by the blow-pipe on charcoal, when finely powdered.

Wood-tin.—Colour hair brown; structure radiated or fibrous; (scarce.)

4. *Zinc.*—Colour tin-white; texture foliated; volatilized by heat.

Carbonate of zinc, calamine-stone.—Colour yellow; earthy; yields to the nail; dull; soft; soluble in muriatic acid.

Sulphate of zinc, blende or black jack.—Also brown and yellow; crystals a tetrahedron; shining; yields to the knife.

CHAPTER XIII.

METALLIC MINERALS.

BRITTLE METALS, AND THEIR ORES.

"TELL John to bring up some boiling water, Frank," said Mr. C.; "and do you, Arthur, fetch the blow-pipe, and light the wax-candle."

"This is our last lesson on minerals," observed Helen: "I am sorry we are so near the close."

A metal was then brought out, of a silver-white appearance, a little tinted with red: the crystals were cubes. Helen thought it silver; but upon referring to the list, she recollected that they had already seen silver and one of its ores, and that the brittle metals were to be the subject of the present lesson. Mr. C. applied a piece to the flame of the candle, in which it melted; and before the blow-pipe, it was changed into vapour, which rested on the charcoal.

"Now, Frank," said Mr. C. "here is a spoon, with which you will stir the water that John pours into the basin."

"Oh! the spoon," exclaimed the little boy; "the spoon is melting! It will be spoiled!"

"It is really melted," said Arthur, looking at Mr. C. "Perhaps it was only wax, coloured to look like metal."

"Two malleable and one brittle metal form the compound; namely, *tin*, three parts; *lead*, five parts; and the metal before you, *bismuth*, seven parts. It is the *fusible metal* of Sir Isaac Newton. It melts a little below the boiling point of water. Bismuth is found native, and in the state of an oxide, a carbonate, and a sulphate. Pour a little nitric acid upon a piece, which, you see, entirely dissolves it. By adding water, it is decomposed, and the white powder is an oxide of bismuth. Perfumers make pearl-powder with bismuth. The metal is useful in taking impressions of coins and metals: it expands as it congeals, and gradually hardens. Among the brittle metals you will find *uranium;* but the mineral has never been found in any state having a metallic appearance. I shall show you the *phosphate*, which is very beautiful. Observe these thin, bright-green plates: they are transparent. The phosphate is, properly speaking, *uranite*. It is found in Cornwall."

"I was going to call it green mica," said Helen; "but I recollected, in time, that *mica* is an earthy mineral. Is any use made of uranite?"

"None, but it is a pleasing specimen in collections; therefore keep that in your hand.

"The next which I shall notice is very useful; *cobalt*. We will first examine these ores. Here are crystals of cobalt, of an octahedral form. Before the blow-pipe they will tinge borax with deep blue, and melt into a metallic globule. The peach-colour of this *arseniate of cobalt* is remarkable: it is called *cobalt bloom*. When the ores of cobalt are reduced, the substance is called *zaffre*. Being fused with flint or glass, it forms *smalt*, which, when ground, becomes *powder-blue*. The blue colour of zaffre is extensively used in painting porcelain, or earthenware. Zaffre, dissolved in muriatic acid, forms a sympathetic ink. Writing held before the fire becomes green, when this solution is used. With spirit of wine the colour is red.

"The softest and most combustible metal is before you; native *arsenic*. Its colour is tin-white, with a bright metallic lustre. The texture is foliated. It is very heavy, and soon turns black by exposure to the air. It fuses easily, burns with a bluish flame, and emits a smell of *garlic;* this scent is a strong indication of *arsenic*

in a metallic ore. The mineral called *mispickel* is an *arseniuret of iron, or arsenical pyrites*, Sometimes it is yellow: this is silvery white. It is massive, and gives fire with steel. Thus there are iron, copper, tin, and arsenical pyrites."

"How fine this yellow mineral is! but who would imagine that arsenic is contained in it? And the next is as fine a red."

"They are both *sulphurets of arsenic*. The yellow specimen is *orpiment:* the red, *realgar*. Both melt before the blow-pipe. The Chinese form realgar into medical cups, and suffer lemon-juice to remain in them. The liquid is used medicinally."

"What a singular looking wine-glass the powdered arsenic is placed in," said Helen: "the stem has such curious white twisted work in it."

"That is produced by arsenic," replied Mr. C. "Arsenic is one of the most violent poisons. I shall now remove the specimens. We cannot be too careful. Do not touch the powder in the glass, Frank."

"What is that beautiful mineral?" said they, as *sulphuret of antimony* was brought forward.

"The needle-like crystals, and shining filaments are, indeed, striking," said Mr. C. "This is a piece of *native* antimony, shining tin, white in colour, granular in its structure. It will yield *to the knife*, and melts easily."

"Can we buy ores of antimony?"

"Certainly; and you will see very fine specimens at the Museum. In the mean time, I will furnish you with a specimen of *crude antimony*, which is the metal combined with sulphur, but freed from the earthy parts by fusing, and suffering it to crystallize. The needle-like striæ are very visible on the dark surface. Try a fragment in the flame of a candle: the white smoke will condense on any cold surface. It is easily beaten into powder."

"Has this yellow mass any antimony in it?"

"That is *Naples-yellow*, an artificial compound of antimony and lead. Antimony is used in forming printing types, in fire-works, and in medicine.

"Our metallic specimens will conclude with *manganese*, which is not found in the state of a metal, but is brittle, and hard as iron. The species before us is called *grey oxide* of *manganese*. The colour is steel-grey: sometimes foliated, often compact. All the varieties are infusible before the *blow-pipe*, and communicate a violet colour to borax. *Wad* is an oxide of this metal, mixed with iron and a small portion of lead. It is rare.

"The *carbonate of manganese* is rose-red, you perceive. It is composed of small crystalline masses. It is heavy, and is found combined with felspar. Manganese combines with a greater

portion of oxygen than any other metal, and easily parts with it. I am going to put powdered manganese into the watch-glass with muriatic acid. Heat will disengage the oxygen from the metal, and the acid will combine with it. Hold that piece of coloured linen ready, Helen."

"It boils already," said Frank; "and at such a distance from the flame, I was afraid the point of it would break the glass."

"What an unpleasant scent?" said Helen.

"Now we have *oxymuriatic* acid, used in bleaching. Hold the linen in the fumes. Observe how the colours begin to disappear. You observe that the linen is moistened."

"I like that experiment very much," said Arthur: "it is easy, and satisfies one completely."

"Manganese," continued Mr. C. "is used at the potters' kiln, for glazing coarse earthenware, of a dark colour. Fine specimens of the mineral are to be seen at the Museum."——

"And so our lessons in mineralogy are ended!" said Arthur. "I am sorry, for they have given us so much pleasure. But I wonder how you could recollect the characters of so many different minerals, sir, and the means of determining them."

"Do not think that I have trusted to my memory, Arthur. I have always consulted some

writer on the science, previous to the commencement of every lesson, short and slight as they have been. I have usually had recourse to '*Bakewell's Introduction to Mineralogy;*' and I believe that many parts will, even now, be very intelligible to Helen and yourself. Accept of the work, therefore; it will often remind you of the lessons and the friends at D—— farm."

"How can we need to be reminded of such very kind friends!" said Helen. "I only wish we were going to live near them."

"You will join us again next year, I hope, my dear. What say you to a journey along the southern coast, and all the pleasures of geology added to it, as we proceed? We shall see sufficient chalk then, Frank. Your mother intends to travel with us, and to take you all with her. My chaise will follow; but we intend to perform our excursion chiefly on foot."

"Oh! that is best of all," said they, "if the chaise may take our minerals and fossils that we find: they would be so heavy to carry."

"They would, indeed," replied Mr. C.; "but there must be moderation even in collecting fossils, remember. And I, too, must recollect that my daily cares require my attention. Let us put away our books. One thing at a time is my practice: it makes less display, and business goes on better. You will add this list to the others that I have given you."

BRITTLE METALS, AND THEIR ORES.

Bismuth.—Native; texture foliated; melts easily; volatilized before the blow-pipe; colour silver-white, tinged with red; soluble in nitric acid.

Uranium, (phosphate.)—Colour green; in thin plates; hard.

Cobalt, (arseniuret.)—In crystals; steel colour.

Arseniate of cobalt, (cobalt bloom.)—Colour red.

Arsenic.—Native; fuses readily before the blow-pipe; soft; heavy; smells like garlic when heated.

Arsenical pyrites; (mispickel.)—Gives sparks with steel; colour silvery-white, sometimes yellow; contains iron.

Sulphuret of arsenic, realgar, and orpiment.—Both melt before the blow-pipe: realgar, red; orpiment, yellow.

Antimony.—Native; colour tin-white; yields to the knife; melts easily; crystals, octahedrons.

Sulphuret of antimony.—Crystals finely needle-shaped; friable; easily fused; soils the fingers.

Manganese, (grey oxide.)—Either foliated or compact; colour steel-grey; brittle; hard; infusible before the blow-pipe.

Black oxide, (wad.)—Rare.

Carbonate of manganese.—Rose-red in colour; heavy.

CHAPTER XIV.

FOSSILS.

"James White is come to ask if you have any work for him," said Arthur to Mr. C., as he came in to breakfast. "He has brought some curiosities from Lewes, where he has been digging chalk; and Helen is talking with him concerning the places where he found them. Here she comes."

"Now, Helen," said Mr. C., "what has James discovered?"

"Oh! a very pretty little urchin,* as we call those that we find on the sea-shore; but it is not the same kind. He has been to his father at Brighton also, and procured a few things there. He says that you can tell us all about them, for he has often had some discourse with you about

* Plate 4, figure 1.

these old-world curiosities; though he always forgets the learned names. But he has given me *files*, *chalk-bottles*, and a *pencil;* and this hollow flint, filled with chalcedony and quartz crystals, is beautiful: I knew *that* immediately."

"You will recompense the labourer for his civility, my dear," said Helen's mother.

"She has tried to make him accept a small gift," said Frank; "but he will not take it: he says they are very common fossils, and he likes to please such a kind-speaking young lady."

"James is a clever, observing man," said Mr. C.: "he has brought me several curious fossils that he collected during his labours in the chalk-pits. I will take care to employ James; and he knows that he is welcome in the kitchen."

"Pray tell me," said Arthur, "what is meant by *old-world* curiosities."

Mineralized remains of animals and vegetables are found in almost every part of the globe, differing very generally from those now existing, particularly zoophytes and shells."

"Are shells easy to be met with in a fossil state?"

"In some counties of England," replied Mr. C., "not a pit can be opened, nor a well dug, without affording an abundance; and what is yet more remarkable, each formation, such as chalk, green sand, lias, oölite, has its fossils, in many

instances, peculiar to itself, and differing from those of other formations. The coal measures, (you can understand that phrase now,) scarcely present a single shell, but abound in vegetable remains, such as ferns, reeds, and other productions unknown to the present world, imbedded in sand-stones and shale. Chalk and other strata afford *echinites* or urchins, corals, *encrinites* or fossil-bones of an unknown lily-shaped animal, shells both fossil and *recent*, that is, at present existing. The blue clay contains the remains of large animals, as the crocodile. The plastic clay near London affords numerous fossil shells. Woolwich sand and clay-beds are noted. Oyster-shells are found near the surface of the ground at Bromley; near which place, at Sundridge Park, there is a vast deposite of shells. The mountain lime-stone of the hills north of the Trent, sometimes called the *Penine* Chain, is almost composed of the fossil encrinites: it is from that formation we obtain the encrinal marble.—(PLATE I. fig. 4.)

"Here is the chain," said Frank, bringing a map. "Cross Fell, Ingleborough, Pendle Hill, and the High Peak, are all in it."

"The name *Penine Mountains* is as old as the time of the Romans. We are told by the authors of '*Outlines of the Geology of England and Wales*,' that it was probably derived from

the old British word *pen*, *(head*, or *summit ;)* but is changed for the term *fell*, and *peak:* both Saxon words, meaning the same as *pen*."

"I like to hear old words and ancient names," said Arthur, writing down the terms.

"There is one more observation I would make," continued Mr. C., "before we begin to take a slight view of the few fossils in our possession. These fossil remains are *nearly* the same in all countries.* If a collection is obtained from the *chalk* of Flamborough Head or Dover Cliffs, or even from Paris or from Poland, eight or nine species out of ten will be the same. If a collection be obtained from *mountain lime-stone*, these will have scarcely any instance of agreement with those in chalk species; but they will be encrinites, corals, and shells peculiar to the lime-stone.

"How very extraordinary! And no one can tell how they came there?"

"Many are the theories, my dear child; and hereafter you may make yourself familiar with them. Come now and learn to recognize the objects themselves.

"The word *fossil*," continued Mr. C., as he uncovered a table with various species, "now generally denotes those minerals dug out of the

* Geology of England and Wales.

earth, which have taken their form from the remains of animals or vegetables. They are also called *organic remains*, and petrifactions.

"Fossils are divided into vegetable and animal remains. This specimen on coal-shale is an example of a mineralized vegetable. (PLATE I. fig. 1.) About four hundred species have been found. A recent discovery of some specimens of the ancient *flora* in the county of Durham will please you.

"In the Derwent mines, many fathoms below the surface, and in a bed of sand-stone, some fine specimens of *lycopodium* appearance, have been found: others were *filices* or ferns. One of the latter stands erect in a space cleared out to reach the lead-ore, its roots firmly bedded in shale: the height is about five feet."

"It was *growing* once," exclaimed Arthur; "and who was alive *then* to see it?"

"*He* only knows," replied Mr. C., "to whom the past, the present, and the future are alike unfolded. It may have been there before the deluge.

"The most remarkable encrinite is found in Germany, in Saxony, Westphalia, and particularly in Brunswick; but there so plentifully, that the stone of which it forms so large a part, is used for building. It is called the *encrinus* or *stone-lily* of Germany. I have not a specimen:

we must therefore have recourse to a very excellent work, '*Parkinson's Organic Remains*,' where we shall find a plate."—(See the FRONTISPIECE.)

"What a curious flower! Is it not a lily turned to stone?"

"It has been thought a petrifaction of that flower, but is now ascertained to be of animal origin. The stem is the jointed back-bone: the flower, part or the whole of the body. Those joints are all moveable."

"Where can we see the real object?"

"There is a fine specimen in the British Museum, among the fossils. My friend, Mr. K. has a small one."

"And we overlooked it!"

"Do not lament, but make yourselves familiar with the forms you see. You will find how wonders multiply around you.

"These bodies differ from the encrinītes, in the joints being pentangular, (FRONTISPIECE, fig. 2;) and thence are named *pentacrinītes*, or *columnar star-stones*. The single joints, or vertebræ, are each marked like a star, with five rays."

"The *cap encrinīte* of Derbyshire is the species that we see so much in the encrinal marble, (PLATE I. fig. 4.) Single joints of this are called *fairy stones* and *Cuthbert's beads*. You have

some, Helen. (PLATE I. fig. 2 and 3.) When joined together, they have been called *entrochæ*, when separate, *trochitæ—wheel-stones* by the Germans, and *tears of the giants*. These smaller bodies are common in many parts of the world, and their various names show how much they have attracted the notice of the country people. The limestone near Bristol is noted for the remains of the *crinoïdæ*, or lily-shaped animals. The species called *Briāreus*, from its numerous arms, is found there."

"Did not James bring a fossil from the green sand?"

"Yes, and he called it a *tulip*. I think it is like those you took from the pit, the first time we walked up L—— hill. We should know their value *now*." (PLATE II. fig. 1.)

"Compare them, they are alike. There is another species, (PLATE I. fig. 5,) like an inverted cone. These fossils were long considered as fruits, and obtained the name of *figs*, *cucumbers*, *nutmegs*, &c. The tulip is common in the green sand of the Isle of Wight, and of this district. These fossils were formerly called *alcyōnia*, but are now distinguished by the name of *siphōnia*. They are animals, having the body supported by a stem, which proceeds from a kind of root. The original substance was spongy, pierced by tubes: it is difficult to distinguish be-

tween these and fossil sponge, sometimes. The alcyōnium is found recent on the Kentish coast."

"Are there fossil sponges too?"

"A very large number are found in that state. Many are found in the cavities of flint, the pores filled with chalcedony. Many flinty nodules have been formed over the remains of alcyōnia, or sponge. The pebbles found in gravel-pits have not been worn down to the singular forms they often assume, but owe them to some animal remains. This species of sponge, (*spongia ramōsa,*) branched sponge, is common, (PLATE II. fig. 2:) it occurs abundantly in the upper chalk, in cylindrical fragments, and in loose, hollow flints. My specimen is a fine one, detached with difficulty from the surrounding chalk, where traces of sponge may be frequently seen, marked by numerous perforations. It is also found in little round masses in flint, the pores filled with siliceous earth or chalcedony. If these chalcedonic sponges are placed in water, or in diluted muriatic acid, the parts are often beautifully produced."

"I shall look about among gravel pebbles for some," said Frank.

"We come next to a family that will greatly interest you," said Mr. C.: "it is almost characteristic of the chalk; there are above one hundred species. It is the *echinite* or *echīnus* family, known by the name of *urchin*, both in a recent

and fossil state. Some of the recent echinites are of a very large size. Some are circular and flattened, studded over with tubercles, having an opening above and below, or at the *summit* and the *base*. These are called *diadems* and *turbans*. You have one, Helen, from the chalk marle at Lewes. (PLATE IV. fig. 1.) When the base is an acute oval, with the apertures at opposite ends, they are called *helmet urchins:* one side of the upper surface has a ridge. A very common kind in chalk, is heart-shaped, and furrowed or sulcated on the upper surface, the smaller end truncated, having an aperture; and another, near the larger end of the base. These are *snake's heart urchins*. (PLATE III. fig. 1, 2.) The *conuli*, or *cap urchins*, have a small aperture in the centre of the base, and one in the margin: these are found in chalk. That is an acute variety, from the flinty chalk in Kent. (PLATE IV. fig. 2 and 3.) Helmets occur only in flinty chalk: they are common in the Kentish chalk-pits. Heart and cap urchins are not found lower than the green sand. The spatangus has recently been observed below the green sand. The *turban*, called *cĭdăris papillata*, is not peculiar to chalk, I believe: you had a beautiful specimen, Helen, from Mr. K."

"But what are these fossils that James called *files?*"

"They are *spines* of a species of cidaris, delicately muricated: there is one on the table, and another imbedded in chalk. The other belongs to the species called *claviger*, club-bearing urchin: they are called *chalk-bottles* by the labourers. They were long supposed to be fossil olives. (PLATE III. fig. 3, 4.) There are also *quoit*, *boat*, *buckler* or *shield* urchins, which you may meet with in your search; they are, at least, to be seen at the Museum. Some are only casts in flint, the outer shell having disappeared, the interior is filled with flint: the common cap-stone echinus is usually in this state. Shells, you have learned, are calcareous earth, which you also know becomes crystalline; the spar of these echinites is of a very peculiar nature—opaque and cream colour."

"That was just the kind of spar that the screw-stones were formed of, that I saw at K—— Hall," said Helen, "and so is this helmet that James gave me: the outer shell is breaking away, the inside is soft chalk."

"Petrifactions are always of the substance in which they are imbedded. I shall refer you to the Museum for *corals* and *madrepores*, which are curious. You will also find a collection of fossil *bones*."

Frank, who had left the room a few minutes, now returned with a piece of stone. Arthur re-

proved him for interrupting Mr. C., and Helen asked him, laughing, why he went for a piece of *hearth-stone.*

"Because," said Frank, "here is something like a cast in flint upon it, and I thought this *was* a proper time. I found it."

"It is a piece of iron pyrites," said Mr. C., "attached to some *fire-stone.* This limestone escaped my memory when I was showing you the calcareous minerals, yet you ought to know it, for the stone is in constant demand for cleaning stone slabs and steps at the doors.* It comes from Godstone in Surrey, and is preferred for lining the insides of chimneys, immediately round the stoves. It is often impure, being mixed with iron pyrites and masses of flint; but the best is somewhat granular, soft, rubs off with a touch of the finger: it consists of lime, sand, grains of dark green chlorite or talc, and shining particles of mica. I have heard it called *malm rock.*"

"I do really ask your excuse, Frank," said Arthur, "for your idea of flint casts on stone has procured us the account of '*hearth-stone.*' We hear so much of it in the streets of London and the vicinity."

"Let us turn our attention to the shells of a

* Sowerby's Mineralogy.

former world," said Mr. C., "and with these our lessons will conclude. These remains are chiefly of the *univalve* division, and are more complex in their structure than recent shells of a similar class. The interior is divided into many *septa* or chambers, like the nautilus at present found, and are furnished with a siphunculus, or tube."

"We shall find our little knowledge of shells useful now," said Helen; "but these flat *cornu ammonis* shells, as I have heard them called, seem to be metal; they look like pyrītes, and they give fire with steel."

"*Ammonītes*, or *serpent stones*, are flat or *discoid*, spiral shells, resembling a serpent coiled up, but without a head: they are known only in a fossil state, and the interior of the shell is usually all that remains, which is commonly a mould in iron pyrītes. The species are numerous, of various sizes, some are three feet in diameter. Here is a group of small ammonites from the Blackdown quarries in Devonshire, which are remarkable for beautiful fossils: that large one is from the *lower* chalk. (PLATE II. fig. 3.) You have a *belemnīte*, Arthur. It is a brown, spathose, radiated stone, generally conical, but sometimes fusiform: the larger end contains a small calcareous body, called a *nucleus*, which has been a shell: it is wanting in your specimen,

and is not so common as the brown, sparry part. The chalk diggers call these belemnites *pencils*. (PLATE II. fig. 4.) The *hamites* is a hooked shell; that specimen is from the green sand at Blackdown; they occur also in the chalk." (PLATE IV. fig. 4.)

"Is this round fossil a shell? it does not look like one."

"That is the singular fossil shell, *nummulite*, so called from its resemblance to a piece of money, (*nummus*.) It is divided into numerous septa; the spire is internal, (PLATE IV. fig. 5;) they are found in many European countries, and in Egypt."

"Are any to be met with in England?"

"Yes, in London clay; probably in green sand, and that of Bagshot Heath; a similar yellow sand occurs on Hampstead Heath; they are possibly to be found there. Dr. Clark found them near the great pyramid at Djiza, imbedded in limestone. They were known there in the time of Strabo, who conceived that they were *petrified lentils*, such as the workmen, employed in the pyramids, had used for food. Some are very large: they will split asunder easily. You would be pleased to find some, Frank: take one, and hand a specimen to Arthur and Helen. *Scaphite*, (PLATE II. fig. 5,) is a spiral shell: the last turn is lengthened, and then suddenly

curved in, or contracted. This is from the Sussex chalk. The *turrilite* is a rare shell of the green sand and chalk. (PLATE IV. fig. 6.) The *gryphite*, from the lias and oölite, is probably not known to you, though there is a recent bivalve of that name. This species is common among fossil shells. (PLATE IV. fig. 7.) It somewhat resembles a boat, with a large incurved beak; the upper valve is flat; it occurs in chalk also. You have a fossil oyster, Arthur. The *terrebrātula* is very common, (PLATE II. fig. 6;) the larger valve is perforated, having the beak rising over that of the upper valve. Fossil bivalves are seldon found in pairs, unless united in a stony mass. The simple univalve shells are very numerous. Here is a *volvaria*, (PLATE IV. fig. 8,) from London clay, and a *melania marginata*, (PLATE II. fig. 7,) from Grignon, near Paris. You must recollect the oft-repeated notice, '*fossile de Grignon*,' in Lamarck's Conchology. Take one of those shells, *voluta spinōsa*, from the same place. There is one more bivalve which we must not forget to notice, which is common in all blue marle, and occurs in chalk. It has deep, oblique furrows, and the margin is waved. It is *inocēramus sulcatus*. (PLATE II. fig. 8.) The Dudley fossil, or *trilobite*, is very curious. By some, it has been considered an insect, others supposed it a bi-

valve shell. The name *trilobite* is derived from the three longitudinal ridges upon the upper surface. Some specimens are almost globular, and seem to indicate that the animal had the power of coiling itself up, like the *oniscus* or millepes. It is found in the limestone near Dudley in Staffordshire. (PLATE IV. fig. 9.)

"I believe I have concluded, my dear children; but I hope that we shall often renew our conversations on this subject, both at this house and at your mother's abode. I will not put away these specimens, you will probably wish to look them over with the list in your hand."

"I hardly hoped for another list," said Arthur: "it will be very useful."

"You may find farther use for it," said Mr. C.: "we are invited to K—— Hall for a few days, and the *three young folks* are especially named."

"Shall we go?"

"To-morrow."

"Then we shall see a stone lily even before we go to the Museum, and Mr. K. will show us his fossils. How much better we shall understand, after this delightful long lesson. Mamma too will see the minerals."

Mr. C. shook hands with his pupils, as they thanked him for his kindness, with all the gratitude of affectionate hearts, and withdrew to his

usual occupations. Arthur soon followed him to the fields. Helen and Frank accompanied Mrs. C. and their mother in their walk, and persuaded them to visit the old tomb in the church; when Frank discovered, greatly to his satisfaction, that it was constructed of Petworth marble.

LIST OF FOSSILS, AND REFERENCES TO THE PLATES.

	Plate	Fig.
Fossil vegetable, on coal shale . . .	I.	1
Cuthbert's beads and screw-stones . . .	I.	2,3
Encrinal marble, composed of columns and single joints of the common entrochite, in mountain limestone	I.	4
Encrinus, or stone lily of Germany *(Frontispiece)*	—	1
Pentacrinus, or columnar star stone *(Frontispiece)*	—	2
An Alcyōnium, in the figure of an inverted cone	I.	5
Fossil sponge, from the chalk	II.	2
Tulip alcyōnium, from the green sand . .	II.	1
Echino-cīdăris, turban urchin from the chalk .	IV.	1
Echino-pileum, (*conulus subrotundus*) cap urchin	IV.	2
An acute variety of the cap urchin, from the Kentish chalk	IV.	3
Echinochorys scutata, helmet urchin; common in flinty chalk; found only in a fossil state .	III.	1
Echino spatagus, (*spatangus cor-anguinum,*) snake's heart; very common in chalk; it is found both recent and fossil . . .	III.	2
Fossil spine, belonging to a species of cidaris, from the upper or flinty chalk . . .	III.	3

	Plate	Fig.
A clavated spine, (*fossil olive*,) from the flinty chalk	III.	4
An ammonite, (or *cornu ammonis*,) from the lower chalk	II.	3
A belemnite, from the chalk at Brighton	II.	4
A chambered univalve shell, found only in a fossil state; very frequent in chalk marle at Folkstone, and occurring in the green sand. The species of this singular, hook-formed shell, *hamites*, are numerous	IV.	4
A nummulite: this singular shell is found in London clay	IV.	5
Scaphites costātus, a rare species from Sussex chalk	II.	5
A turrilite, from the green sand, (rare)	IV.	6
A gryphite, from the blue lias, Portland	IV.	7
Inocēramus sulcatus, found only fossil, in blue marle and chalk	II.	8
A species of the very common fossil shell, *terrebrātula*	II.	6
Melania marginata, a fossil shell from Grignon, France: found also in England, in London clay, &c.	II.	7
A Volvaria, from London clay	IV.	8
The Dudley fossil, or trilobite	IV.	9

Fossil teeth were in common use as ornaments a century since. Several strings of them have been discovered in Wiltshire, supposed to have belonged to the ancient Britons. Fossil teeth occur in the vicinity of Bath.*

* Geology of England and Wales.

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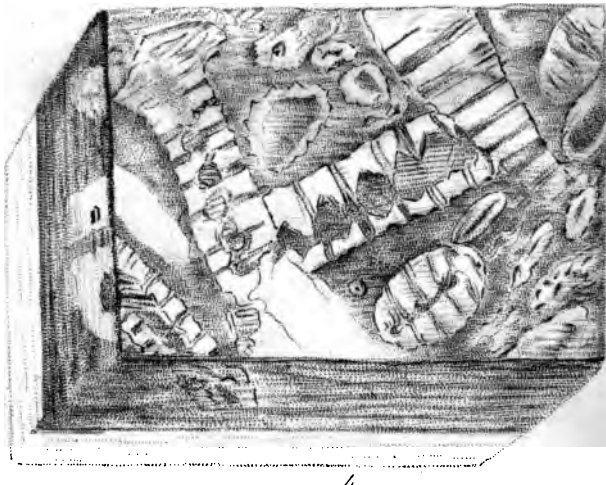

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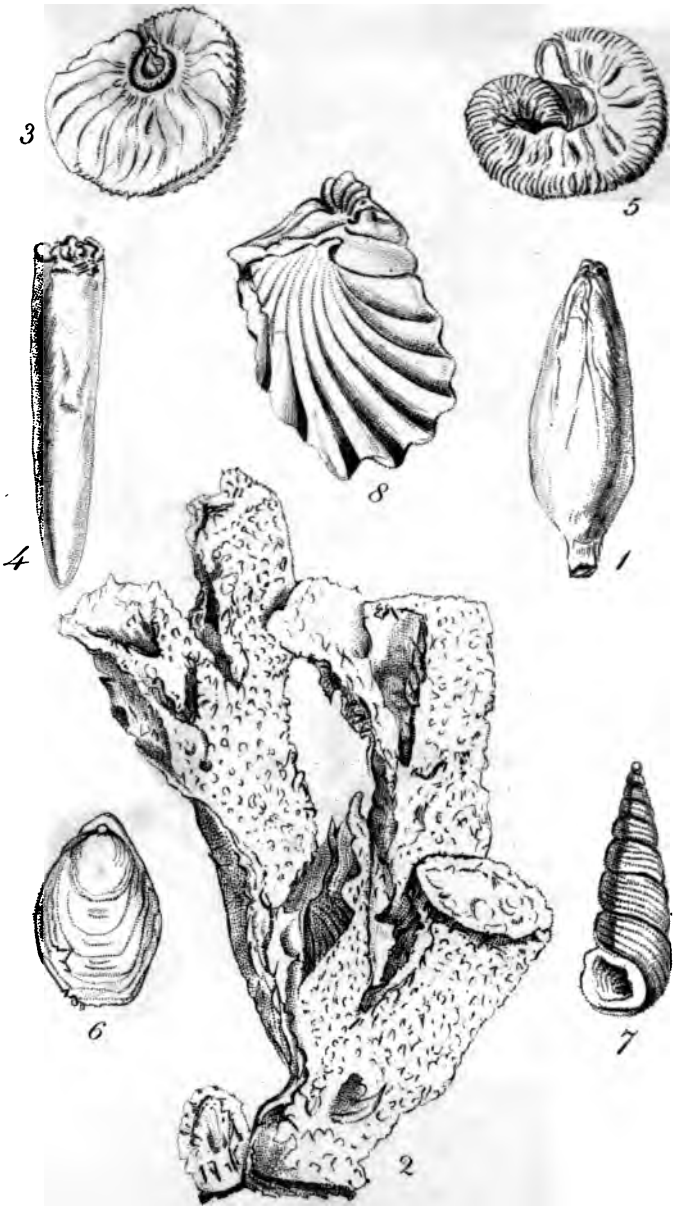
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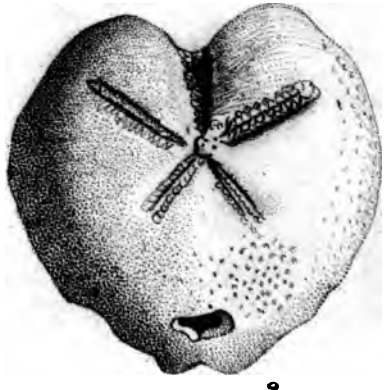

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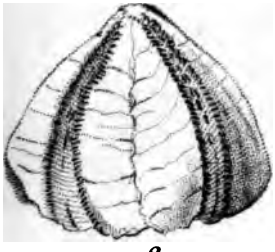

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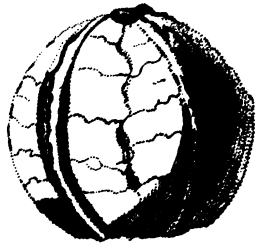

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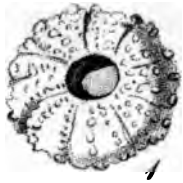

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